PROFINET

Manual / Users Guide

Part No 735795-01, Doc. No 735795 Ver.01

LEINE LINDE

Contents

Specifications and content in this document are subject to change without prior notice due to our continuous strives to improve functionality and performance of our products.

1. Introduction

Thank you for choosing this device produced by the Swedish encoder manufacturer Leine & Linde. In your hands you have a state of art component, ready to be used in the outmost demanding environment. This absolute encoder equipped with PROFINET interface, enable you to design high performance automation systems.

This manual describes the installation procedures and configuration of an absolute encoder with PROFINET interface. If you are in need of assistance thru the system design phase, commissioning or during operation, please make sure that you contact your local Leine & Linde representative.

1.1 Applicability of manual

This product manual is applicable to the absolute encoder versions equipped with PROFINET interface within the following encoder series:

RSA 607	RHA 607
RSA 608	RHA 608

Leine & Linde is a company that often customizes the product to fit individual requirements of our customers. Such customized products may therefore not be fully compliant with the descriptions in this product manual. Customized encoder devices are indicated by its type label, and marked 69X where the “9” digit in the second position indicate that the device has some customized parameters. Encoder series with the following name and type plate information may therefore have deviating functional performance.

RSA 697	RHA 697
RSA 698	RHA 698

If your product is of the above mentioned type, contact Leine & Linde to obtain the product’s complete functional description.

1.2 About Leine & Linde

For more than 40 years, the Swedish based company Leine & Linde has concentrated on one thing – development and manufacturing of advanced encoders that meet the most rigorous demands a user can place on them. That is why a wide assortment of incremental and absolute encoders with obvious concentration on robust products and quality down to the last detail can be offered. Leine & Lindes encoders provide the utmost in reliability year after year, in working conditions where vibration, dirt, cold and other harsh environments are common.

Leine & Linde can meet very specific individual demands. The encoders are easily adopted due to a modular design in the collection exactly to the customer’s needs with respect to resolution, electrical connections and interfaces, voltage, casings, etc. That is due to the fact that tomorrow’s technology is already used today in Leine & Linde products. Leine & Linde concentrate on advanced development of intelligent encoders with integrated ASICs, new special features and with adaptations to

different field bus systems. This enables us to meet the need for increasingly effective and dependable machines and automation to an even higher degree.

1.3 About absolute encoders

With an absolute encoder each angular position is assigned a coded position value generated by a code disc equipped with several parallel fine graduations tracks which are scanned individually. On single turn encoders, i.e. an encoder producing absolute positions within one revolution, the absolute position information repeats itself with every revolution. So called multi turn encoders can also distinguish between revolutions. The numbers of unique revolutions is determined by the resolution of the multi turn scanning and repeats itself after the total resolution is reached. A benefit of absolute encoder type is that if the encoder loses power, the encoder is able to keep track of its position also if the shaft is turned during the power loss. This is due to the genuine absolute scanning principle.

An absolute encoder can also be used to calculate a digital speed value. By internally dividing the difference in position with a small delta time an accurate speed value can be calculated and transmitted to the subsequent electronics for closed loop control.

1.4 About PROFINET technology

PROFINET is the open industrial Ethernet standard of PROFIBUS & PROFINET International (PI) for automation. PROFINET uses TCP/IP and IT standards, and is in effect, real-time Ethernet. The PROFINET concept features a modular structure so that users can select the cascading functions themselves. They differ essentially because of the type of data exchange to fulfill the partly very high requirements of speed.

In conjunction with PROFINET, the two perspectives PROFINET CBA and PROFINET IO exist. PROFINET CBA is suitable for the component-based communication via TCP/IP and the real-time communication for real-time requirements in modular systems engineering. Both communication options can be used in parallel.

PROFINET IO was developed for real time (RT) and isochronous real time (IRT) communication with the de-centralized periphery. The designations RT and IRT merely describe the real-time properties for the communication within PROFINET IO.

To achieve these functions, three different protocol levels are defined

- TCP/IP for PROFINET CBA and the commissioning of a plant with reaction times in the range of 100ms
- RT (Real-Time) protocol for PROFINET CBA and PROFINET IO applications up to 1 ms cycle times
- IRT (Isochronous Real-Time) for PROFINET IO applications in drive systems with cycles times of less than 1ms

Interfacing the peripherals devices such as encoders is implemented by PROFINET IO. Its basis is a cascading real-time concept. PROFINET IO defines the entire data exchange between controllers (devices with "master functionality") and the devices (devices with "slave functionality"), as well as parameter setting and diagnosis.

PROFINET IO is designed for the fast data exchange between Ethernet-based field devices and follows the provider-consumer model. The configuration of an IO-System has been kept nearly identical to the "look and feel" of PROFIBUS.

A PROFINET IO system consists of the following devices:

- The IO Controller, which controls the automation task.
- The IO Device, which is a field device such as an encoder, monitored and controlled by an IO Controller.
- The IO Supervisor is software typically based on a PC for setting parameters and diagnosing individual IO Devices.

An application relation (AR) is established between an IO Controller and an IO Device. These ARs are used to define communication relations (CR) with different characteristics for the transfer of parameters, cyclic exchange of data and handling of alarms.

The characteristics of an IO Device are described by the device manufacturer in a General Station Description (GSD) file. The language used for this purpose is the GSDML (GSD Markup Language) - an XML based language. The GSD file provides the supervision software with a basis for planning the configuration of a PROFINET IO system.

Within PROFINET IO, process data and alarms are always transmitted in real time (RT). Real time in PROFINET is based on the definition of IEEE and IEC, which allow for only a limited time for execution of real-time services within a bus cycle. The RT communication represents the basis for the data exchange for PROFINET IO and real-time data are always treated with a higher priority than TCP (UDP)/IP data.

1.5 Encoder Profiles

Profiles are pre-defined configurations of the functions and features available from PROFINET for use in specific devices or applications such as encoders. They are specified by PI (PROFIBUS & PROFINET International) working groups and published by PI. Profiles are important for openness, interoperability and interchangeability, so that the end user can be sure that similar equipments from different vendors perform in a standardized way. Leine & Linde comply with the definitions in the encoder profile 3.162, version 4.1. The encoder device profile describing encoder functionality and additional information about PROFINET can be ordered from PROFIBUS User Organization, PNO or directly from Leine & Linde AB.

PROFINET is generally defined by PROFIBUS & PROFINET International (PI) and backed by the INTERBUS Club and, since 2003, is part of the IEC 61158 and IEC 61784 standards.

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D 76131 Karlsruhe
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Fax: + 49 721 96 58 589
Web: www.profibus.com

2. Declaration of conformities

This device conforms to prevailing legal requirements and is designed in accordance with proper engineering praxis. A certificate of conformance can be provided upon request from Leine & Linde.

3. Technical and commercial support

Leine & Linde are represented by subsidiaries in many countries around the world. In addition to the address listed here, there are many services agencies and distributors located worldwide ready to reply to commercial enquires or technical support. For more information, please visit our website or contact Leine & Linde in Strängnäs, Sweden.

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3.1 References

Profile Encoders for PROFIBUS and PROFINET V4.1, Order No 3.162

Profile Drive Technology, PROFIdrive V4.1, Profibus International, Order Nr: 3.172

PROFIBUS Encoder Profile V1.1, Profibus International, Order Nr: 3.062
PROFIBUS Guidelines, Part 1: Identification & Maintenance Functions V1.1, Profibus International, Order Nr: 3.502

PROFIBUS Guidelines, Part 3: Diagnosis, Alarms and Time Stamping V1.0, Profibus International, Order No. 3.522

PROFINET – Application Layer Service Definition – Application Layer Protocol Specification, Version 2.0, Profibus International, Order No. 2.332

PROFIBUS Guidelines: PROFIBUS Interconnection Technology V1.1, Profibus International, Order No. 2.142

PROFINET Guidelines: PROFINET Cabling and Interconnection Technology V1.99, Profibus International, Order No. 2.252

3.2 Abbreviations

PI	PROFIBUS and PROFINET International
IO	Input/Output
DO	Drive Object
DU	Drive unit
AR	Application Relation
CR	Communication Relation
MLS	Master Sign-Of-Life
RT	Realtime Ethernet
IRT	Isochronous Realtime Ethernet
IsoM	Isochronous Mode
LLDP	Link Layer Discovery Protocol
GSD	General Station Description
GSDML	General Station Description Markup Language
UDP	User Datagram Protocol
TCP	Transmission Control Protocol

IP	Internet protocol
DHCP	Dynamic Host Configuration Protocol
TFTP	Trivial File Transfer Protocol
MAC	Media Access Control
I&M	Identification & Maintenance

4. Installation

A summary of the PROFINET guideline: PROFINET Cabling and interconnection Technology V 1.99, Profibus International, Order No 2.252 is provided in this section.

4.1 Cables and standards

Two shielded copper cables twisted in pairs are defined as the normal transmission medium for PROFINET networks. In such networks the signal transmission is performed in accordance with 100BASE-TX at a transmission speed of 100 Mbps (Fast-Ethernet).

Only shielded cables and connecting elements are allowed in a PROFINET network. The individual components have to satisfy the requirements of Category 5 in accordance with IEC 11801. The entire transmission path has to meet the requirements of Class D in accordance with IEC 11801. Furthermore, PROFINET cables shall have a cable cross-section of AWG 22 in order to enable even complex cabling structures through minimum damping. For this reason, the specification of the PROFINET cables supports a modular setup, which ensures an IEC 11801-compliant structure on adherence to simple installation rules.

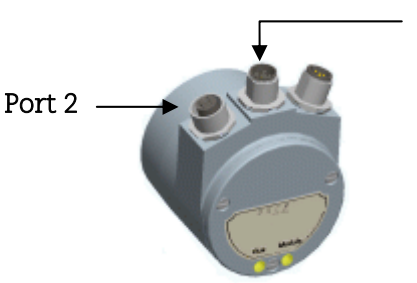
Transmission channels lengths are determined by the type of cable being used. The choice of cable is to be such that a transmission channel length of 100 meter is achieved between two active network devices. The use of a high number of plug connections has a negative effect on attenuation and reflection and consequently reduces the transmission channel length. A maximum of three interconnections can be inserted between two active devices without reduction of the permissible transmission lengths of 100 meters.

4.2 Connectors and pin configuration

A major criterion for use in industry is the handling of local connection systems. Connectors for M12 are available for this purpose.

M12 connectors are used for PROFINET data communication of the encoder, constituted by a 4-pin female shielded D-coded version.

The correct arrangement of the bus connectors is specified as follows:

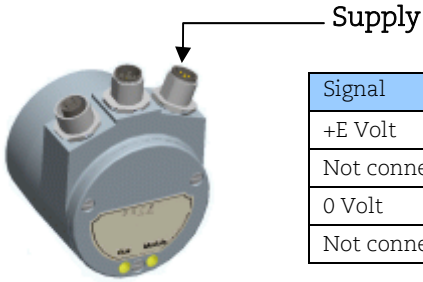


Signal	Function	Pin
Tx+	Transmission data +	1
Tx-	Transmission data -	3
Rx+	Receiver data +	2
Rx-	Receiver data -	4

Note: The encoder provides integrated switch functionality between the two M12 connectors used for PROFINET communication. It is important to distinguish between these ports when IRT-communication is used.

The M12 connectors used for power supply of the encoder is constituted by a 4-pin male shielded A-coded version.

The correct arrangement of the power supply line is specified as follows:



Signal	Function	Pin
+E Volt	Power supply (10..30 Vdc)	1
Not connected	-	2
0 Volt	0 Volt	3
Not connected	-	4

Note: Passive T-couplings are not possible to use in a PROFINET network. All devices must be connected through active network components

4.3 Shielding concept of the encoder

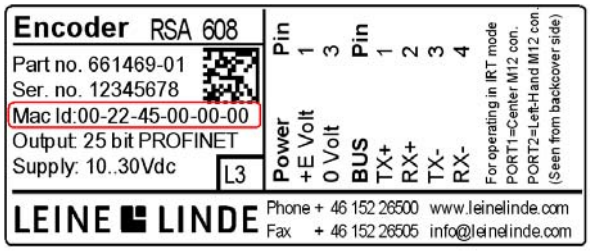
Automation systems in an industrial environment are subjected to high levels of electromagnetic disturbance. Switching large electrical loads creates high interference levels that can be picked up in various ways by electronic devices with detrimental effects. Even under such conditions, electric components within an automation system must still guarantee a continuous, uninterrupted function.

The electromagnetic compatibility (EMC) of the entire plant must be ensured by using suitably designed components and assembling them correctly to make up the system. Data cabling is considered as a passive system and cannot be tested for EMC compliance individually. Nevertheless, cabling and connection elements for PROFINET support compliance with devices requirements by providing a high-quality, comprehensive shielding concept.

To achieve the highest possible noise immunity and resistance against other EMC related disturbances the bus and power supply cables shall always be shielded. The screen should be connected to ground on both ends of the cable. In certain cases compensation current might flow over the screen.

4.4 MAC-address

To make the device unique it is given an ID, i.e. the MAC address, which is a string, loaded in the device. The MAC address is constituted by a 6 byte Ethernet address for each individual station and is unique worldwide. A MAC-ID consists of two parts, the first 3 bytes represents the manufacturer-specific ID and the last 3 bytes represents a consecutive number. For the encoder is the MAC address always printed on the encoder label for commissioning purposes. See picture below.



4.5 LED indication

The following table defines diagnostic indications shown by the encoders two bi-colored LEDs.

Bus	Module	Meaning	Cause
Off	Off	No power	
Red	Green	No connection to another device. Criteria: No data exchange	- Bus disconnected - Master not available / switched off
Blinking* red	Green	Parameterization fault, no data exchange Criteria: Data exchange correct, however the encoder did not switch to the data exchange mode	- Slave not configured yet or wrong configuration - Wrong station address assigned - Actual configuration of the slave differs from the nominal configuration
Green	Red	System failure	Diagnosis exists, slave in data exchange mode
Green	Green	Data exchange and encoder functions properly	
Blinking* green	Blinking green	Firmware upgrade in process	
Blinking* red	Blinking red	Failure during firmware upgrade	

*)The blinking frequency is 0.5 Hz. Minimal indication time is 3 seconds

5. Configuration example

This chapter will illustrate how to setup and configure a PROFINET encoder for working in RT Class 1 mode with SIMATIC MANAGER. In the following examples Siemens STEP 7 V5.4 +SP5 PLC and CPU 315F-2PN/DP is used. Please refer to the manufacturer if other configuration tools are being used.

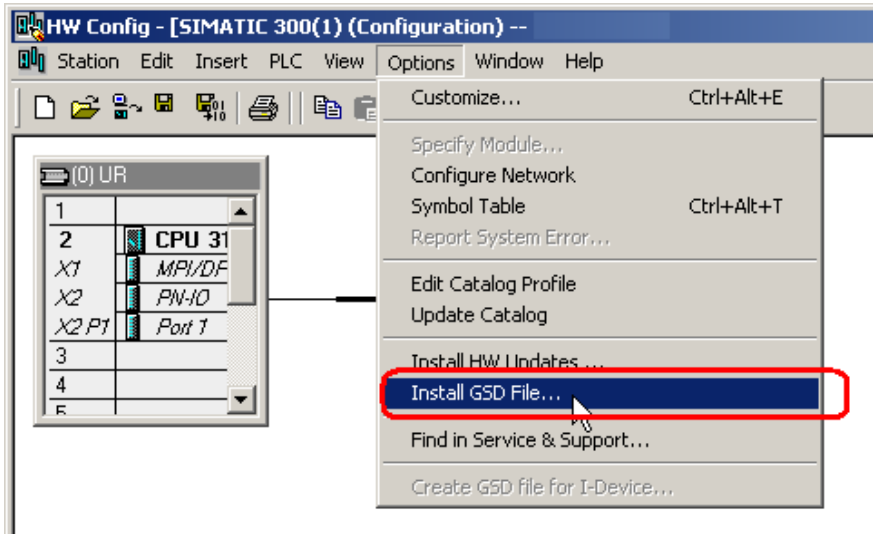
5.1 Device description file installation (GSDML)

In order to start using an absolute encoder with PROFINET interface, a device description file needs to be downloaded and imported to the configuration software. The device description file is called a "**G**eneric **S**tation **D**escription **M**arkup **L**anguage" file and contains the necessary implementation parameters needed for a PROFINET IO device.

The GSDML file can be downloaded from www.leinelinde.com

GSDML file
GSDML-V2.2-LL-RxA600-xxxxxx.xml

Installation of GSDML-files in SIMATIC MANAGER:

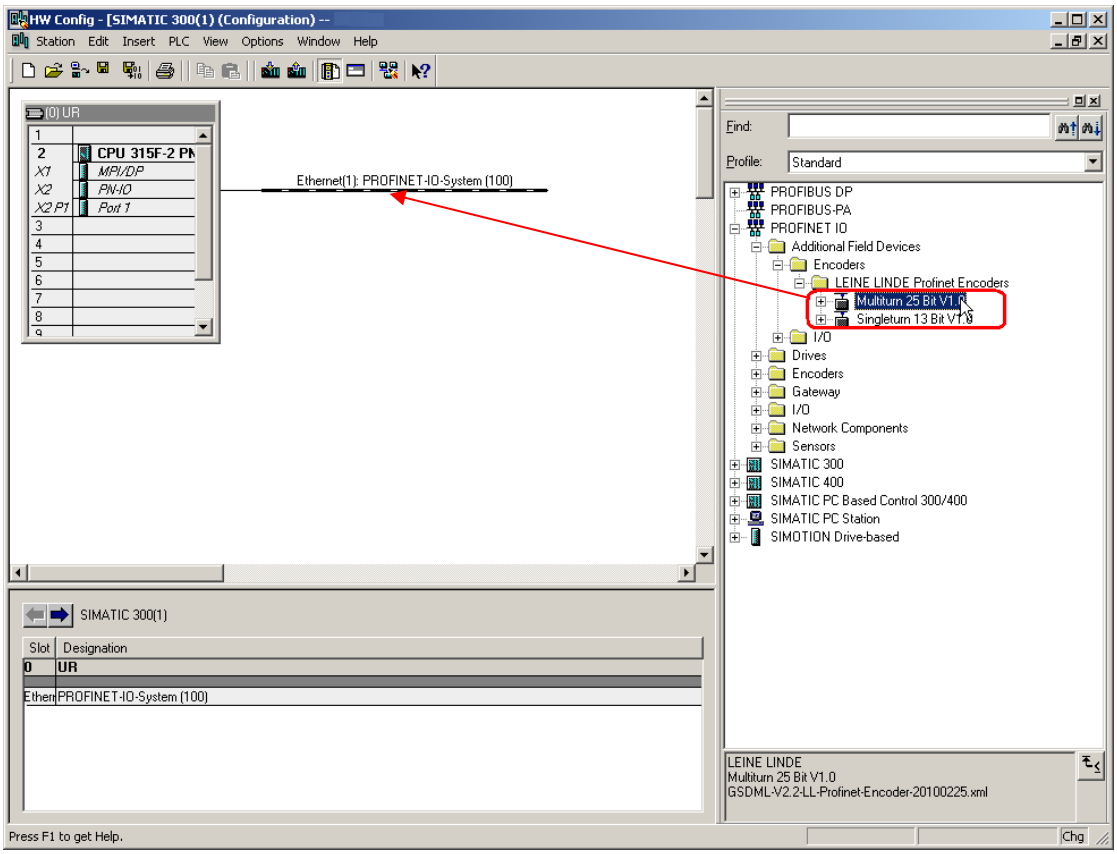


1) Select Options -> Install GSD File and click the "Browse" button to navigate to the location of the GSD file. If a bitmap picture representing the encoder is requested, make sure that the bitmap file is located in the same folder as the GSDML file. A bitmap file is included in the zip-file downloadable from www.leinelinde.com.

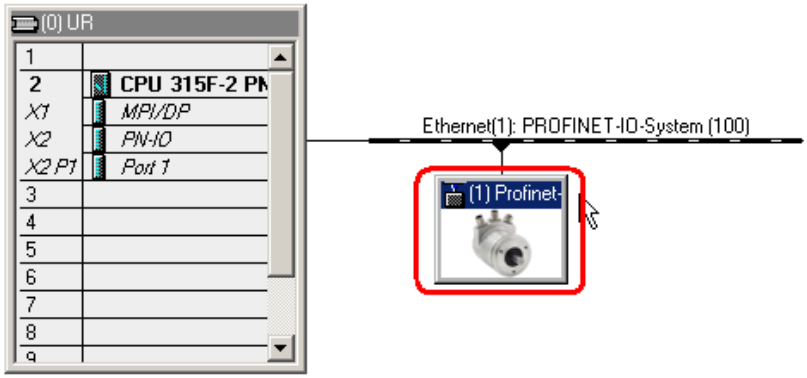
2) Select the GSD file and click the "Install" button to start installing the selected GSD file.

5.2 Setting the encoder configuration

When the GSD file has been installed the encoder can be found in the SIMATIC MANAGER-> HW Config under PROFINET IO->Additional Field Devices->Encoders->LEINE LINDE PROFINET Encoders. Select either multi turn 25 bit or single turn 13 bit encoder, dependent on the type of encoder to be configured. Drag and drop the encoder onto the PROFINET IO system as shown in the picture below. In the example below a 25 bit multi turn encoder was chosen.

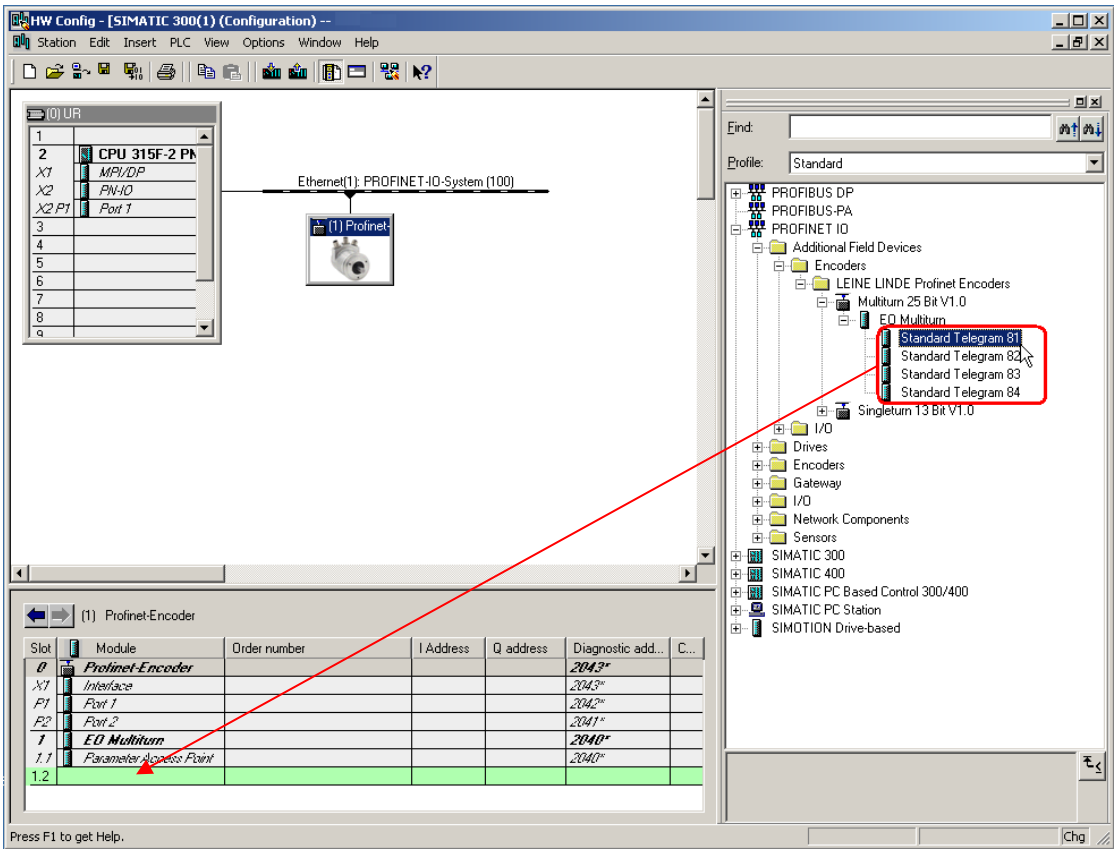


When correctly done, an encoder will appear on the PROFINET IO system as shown in the picture below.

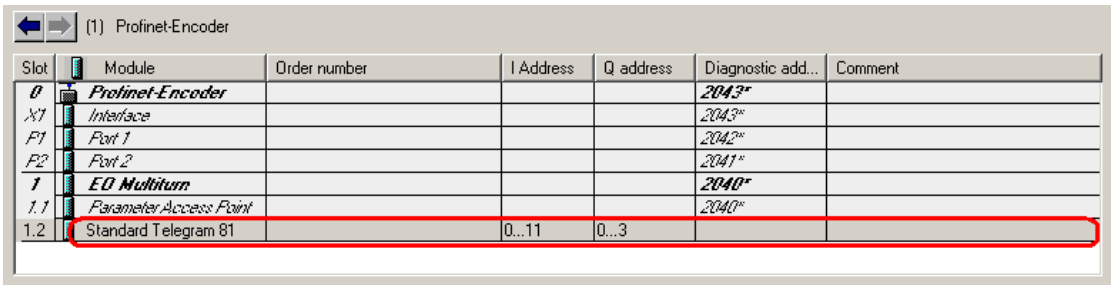


The next step will be to choose the data length and the type of data that should be sent to and from the controller. This is done by choosing different telegrams.

Available telegrams for the multi turn 25 bit encoder can be found under Multiturn 25 Bit > EO Multiturn. In the example below standard telegram 81 is used. Drag and drop the telegram onto slot 1, sub slot 2 as shown in the picture below. For more information regarding the different telegrams refer to chapter 6.4.

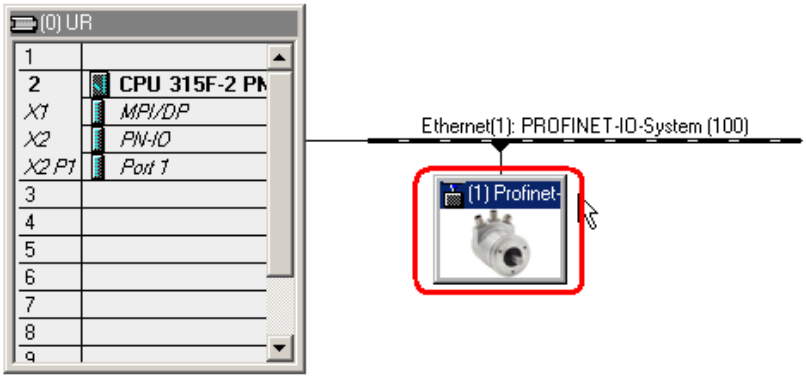


The “Standard Telegram 81” will appear on slot 1 sub slot 2.

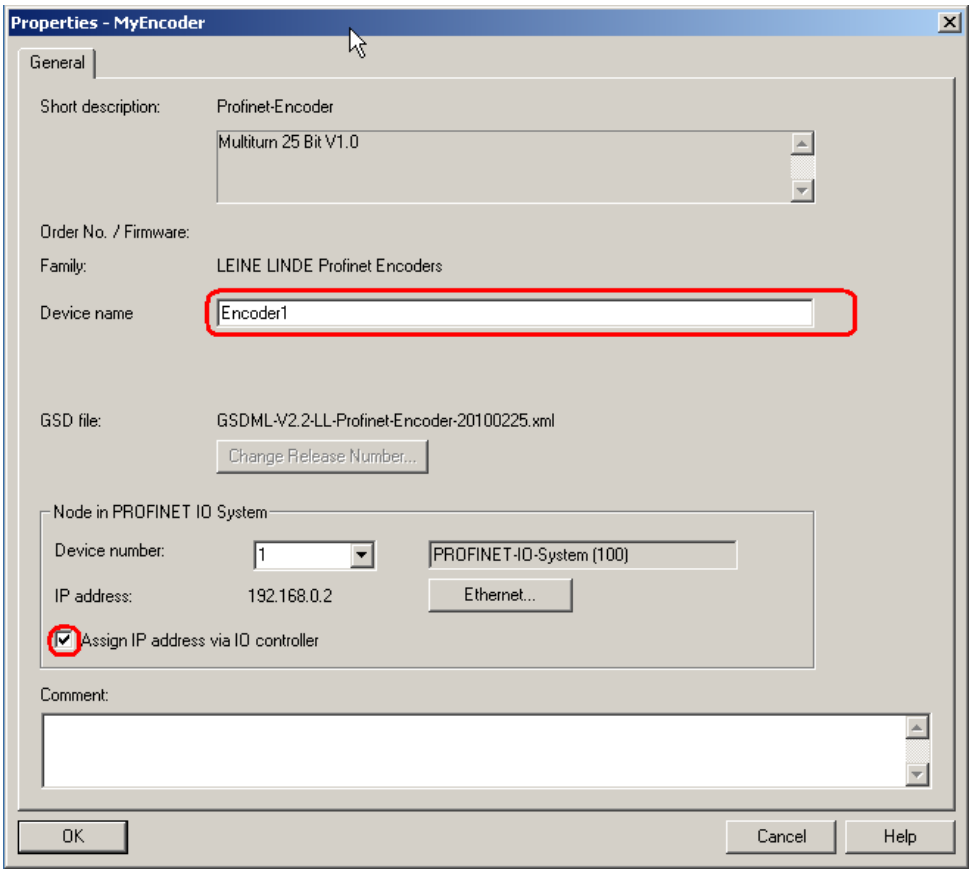


5.3 Set encoder device name

In PROFINET network all IO devices needs to have a unique device name. Leine & Linde's PROFINET encoders are delivered without any device name preset from the factory. To set the encoder device name, double click on the encoder icon to open the Properties window.

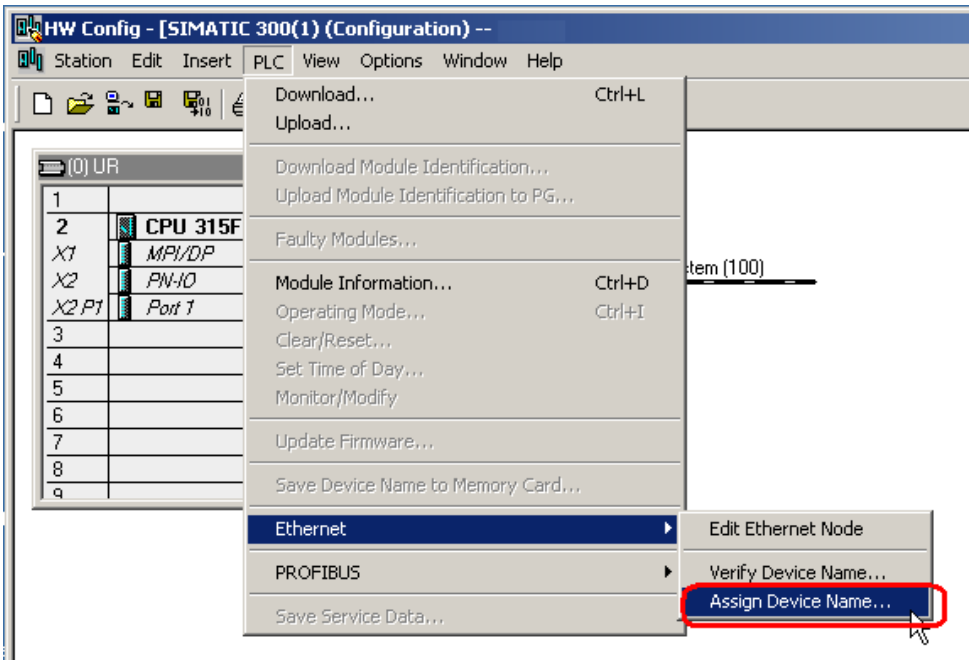


In the Properties dialog window, enter an appropriate device name in the "Device name" field.

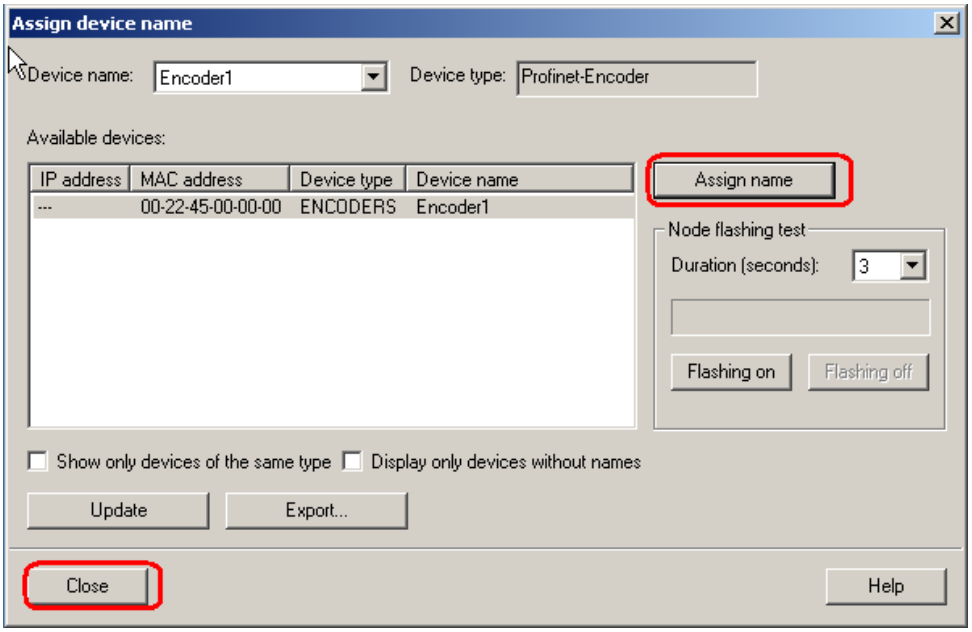


Make sure that the checkbox" Assign IP address via IO controller" is checked, if the IP address for the encoder should be assign via the IO controller.

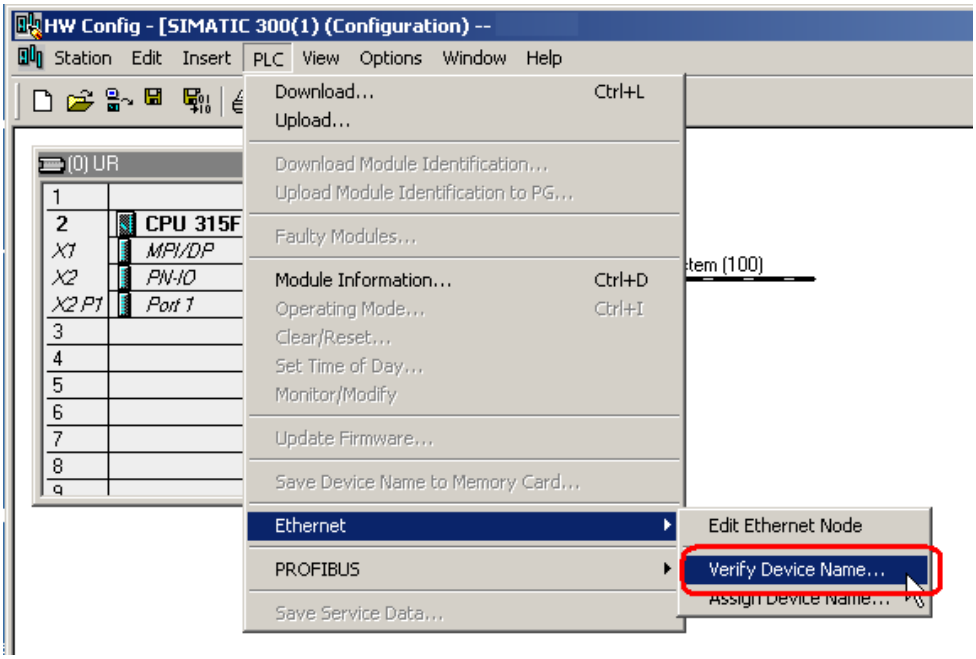
Then select PLC-> Ethernet->Assign Device Name to open the “Assign device name window”.



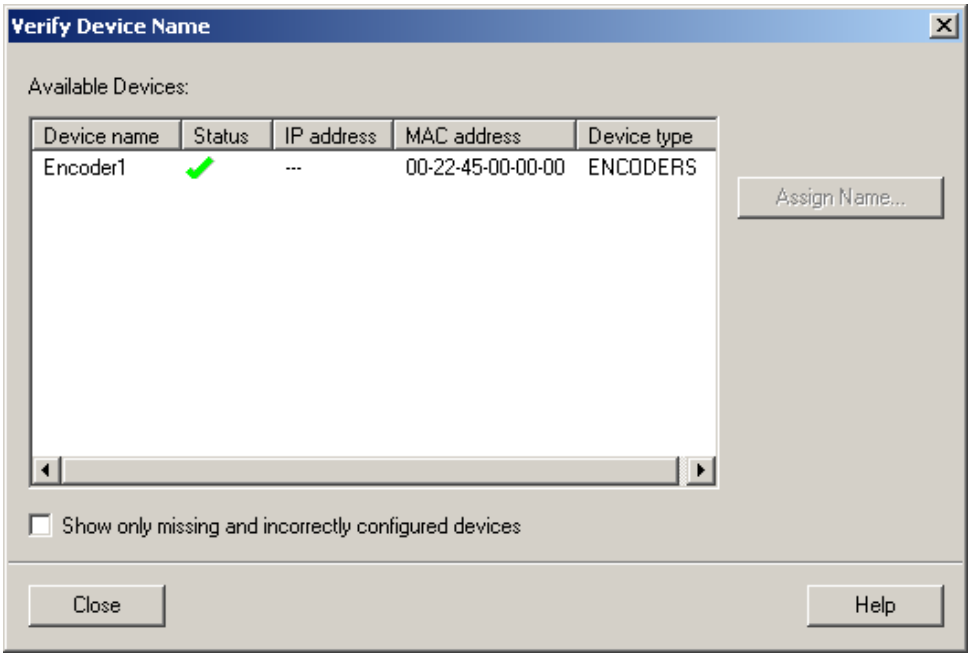
Choose the device on which the device name should be changed and then click on the “Assign name” button to adopt the changes and then click on the “Close” button.



After changing device name, it is recommended to verify the performed changes. This is done by opening the “Verify Device Name” window found under PLC->Ethernet->Verify Device Name.

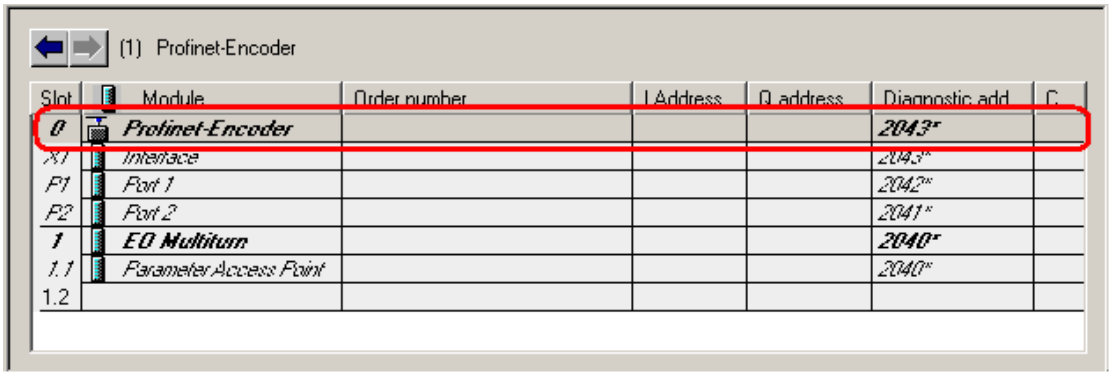


In the”Verify Device Name” dialog window, verify that the “Device name” has changed and the status is OK as shown in the picture below.

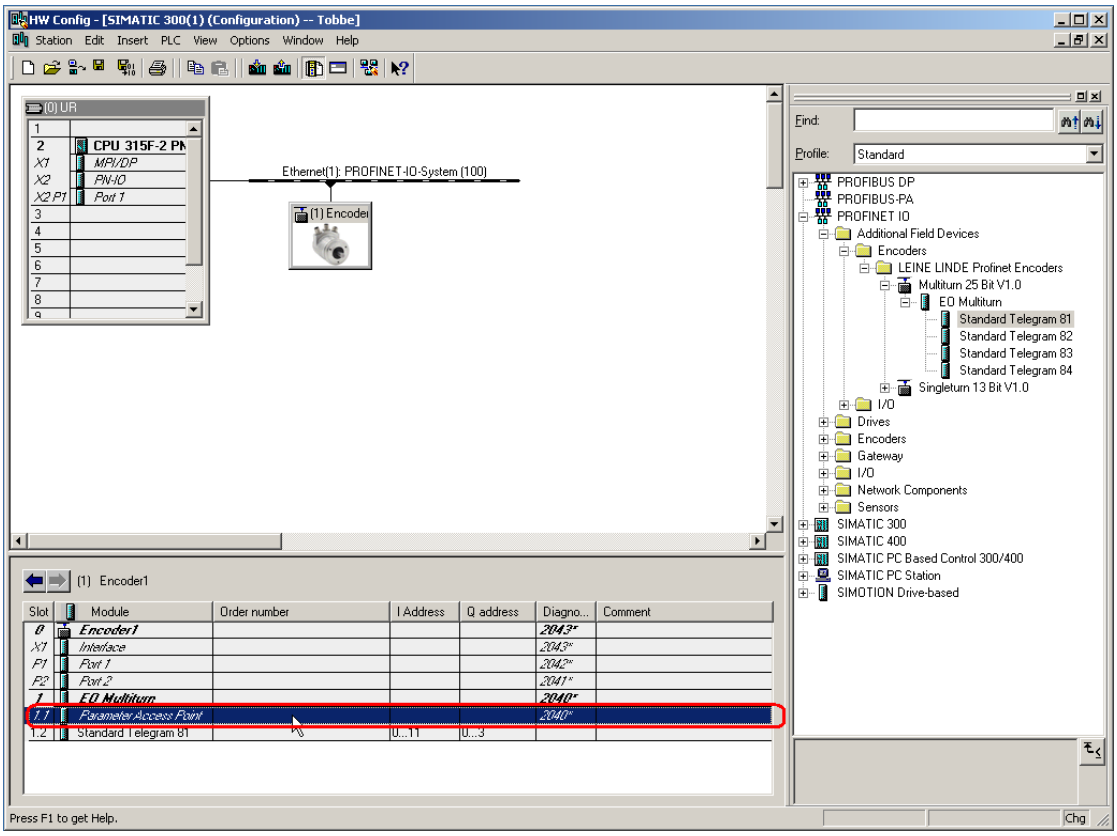


5.4 Setting encoder parameters

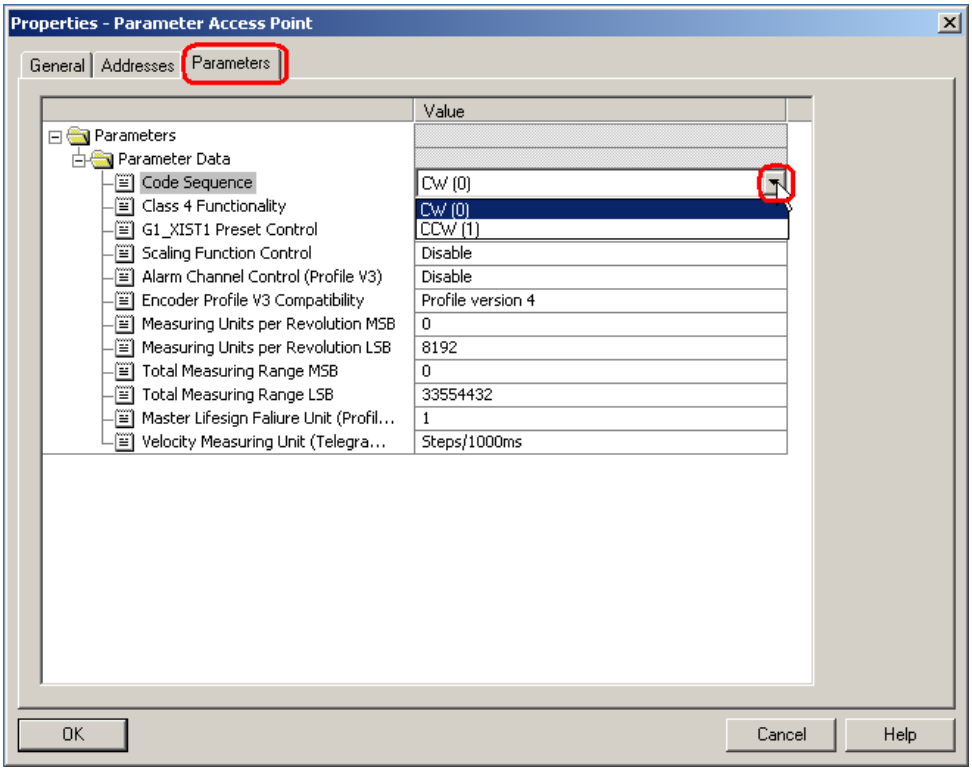
This chapter describes how to change the user parameters in the encoder. The way to open the Properties window is depending on which version of GSDML-file that is used. To set the parameter data while using a GSML-file with a release date earlier than 2010-01-01, double click on the field under slot 0 according to the picture below to open the Properties window. The release date of the GSDML-file is a part of the filename of the file. For example : “GSDML-V2.2-LL-RxA600-**20090512**.xml” was released the 12th of may 2009.



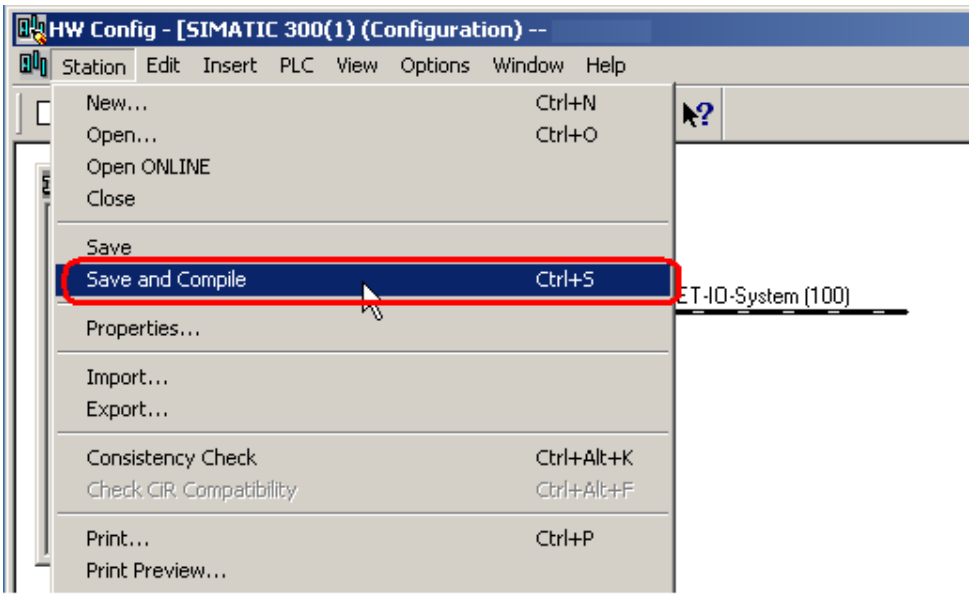
To set the encoder user parameters using a GSDML-file with a release date after 2010-01-01, double click on the “Parameter Access point” field located under slot 1.1 as shown below to open the Properties window.



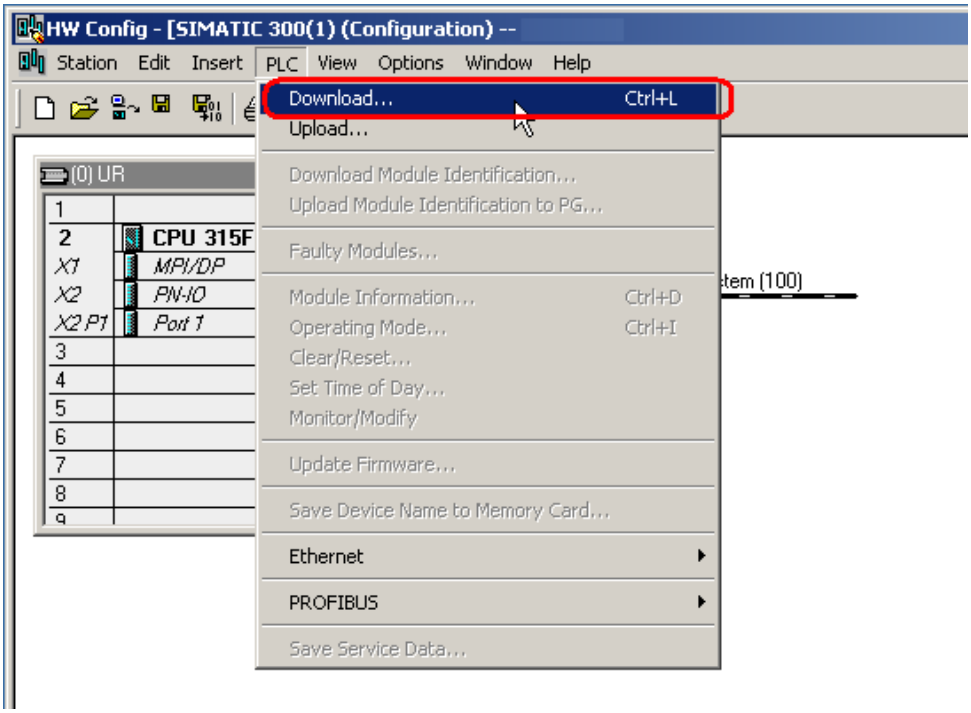
In the Properties window, choose the “Parameters" tab.
To set the parameter data change the value of the different parameters by clicking on the drop down list in the “Value” field for the respective parameter. For more information regarding parameter data, see chapter 9.



When the configuration and parameterization of the device has been done, the settings need to be saved and compiled. This is done by clicking on the “Save and Compile” option under the “Station” tab.



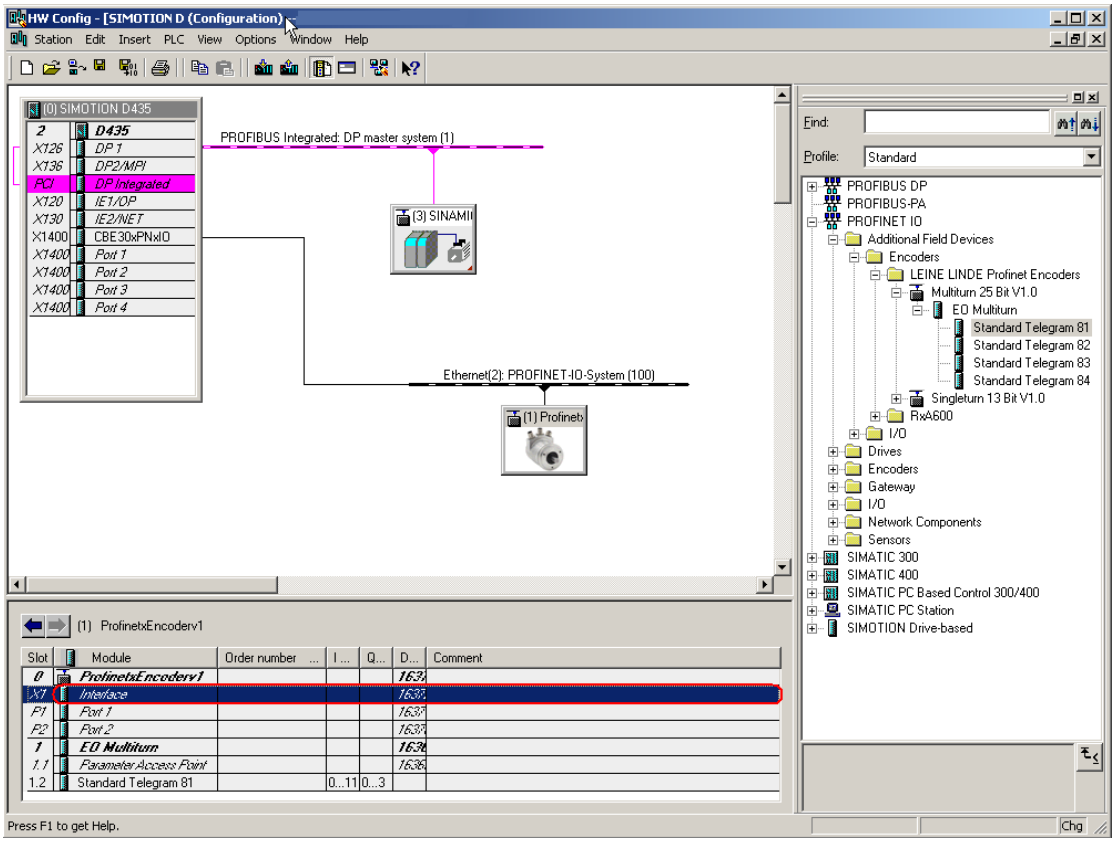
Then the settings need to be downloaded to the IO-controller.
This is done by clicking on the “Download” option under the “PLC” Tab.



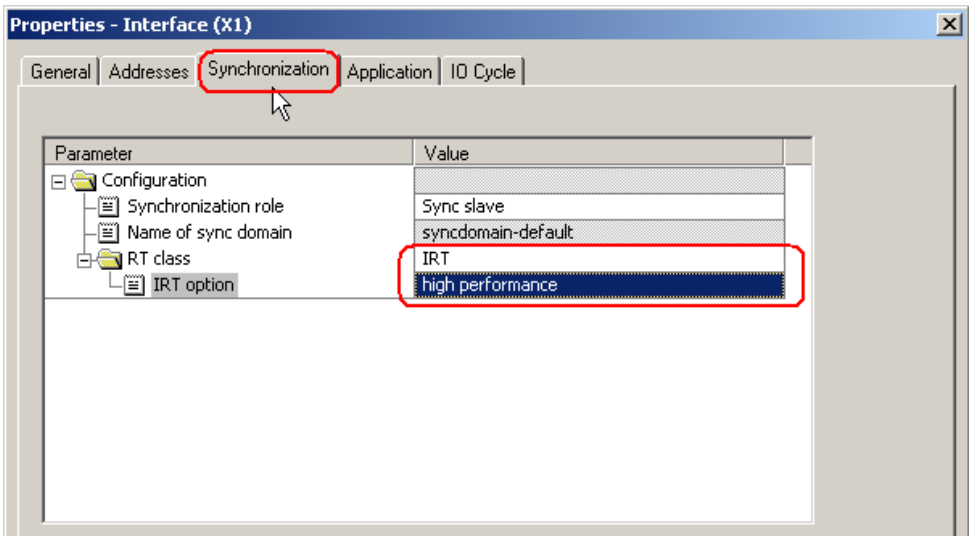
5.5 Isochronous Real Time Settings (RT Class 3)

This example is intended to illustrate the commissioning of a PROFINET encoder in isochronous operation. In the example below STEP 7 v5.4 SP5 and SIMOTION D435 motion controller is used. The basic principal for configuration and parameterization of the encoder is the same as described in chapter 5.2 & 5.3.

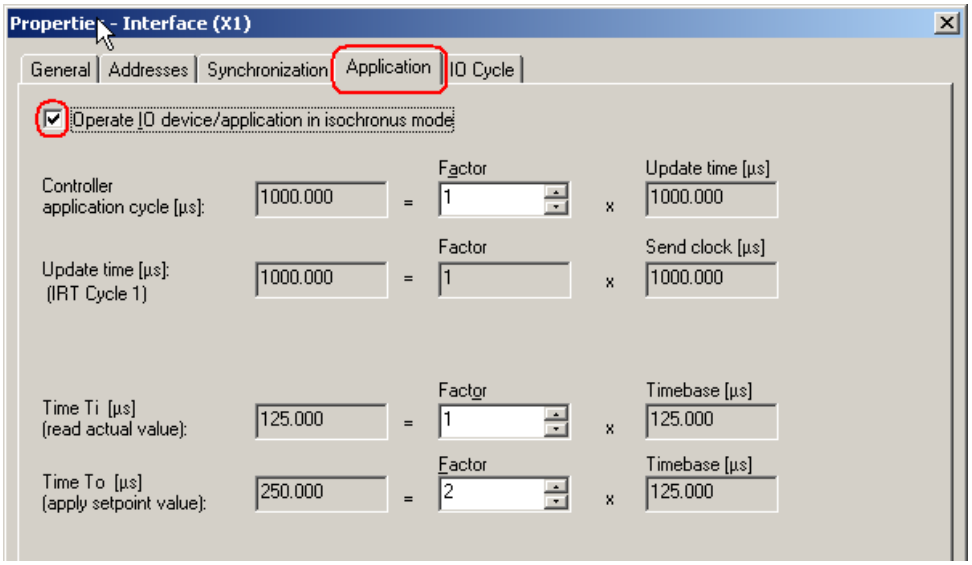
To set the IRT settings of a Leine & Linde encoder, double click on the “Interface” field located under slot 0, sub slot X1 to open the Properties window and follow the instruction below.



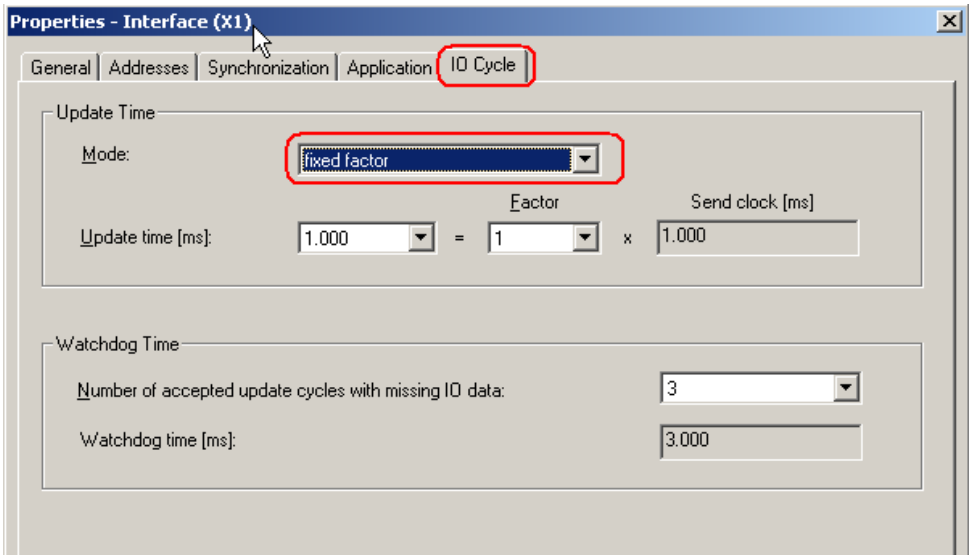
Under the “Synchronization” tab change the value for the Parameter “RT Class” to IRT and the “IRT option” parameter to ”High Performance” according to the picture below.



Under the “Application tab” check the box for “Operate IO device/application in isochronous mode”.

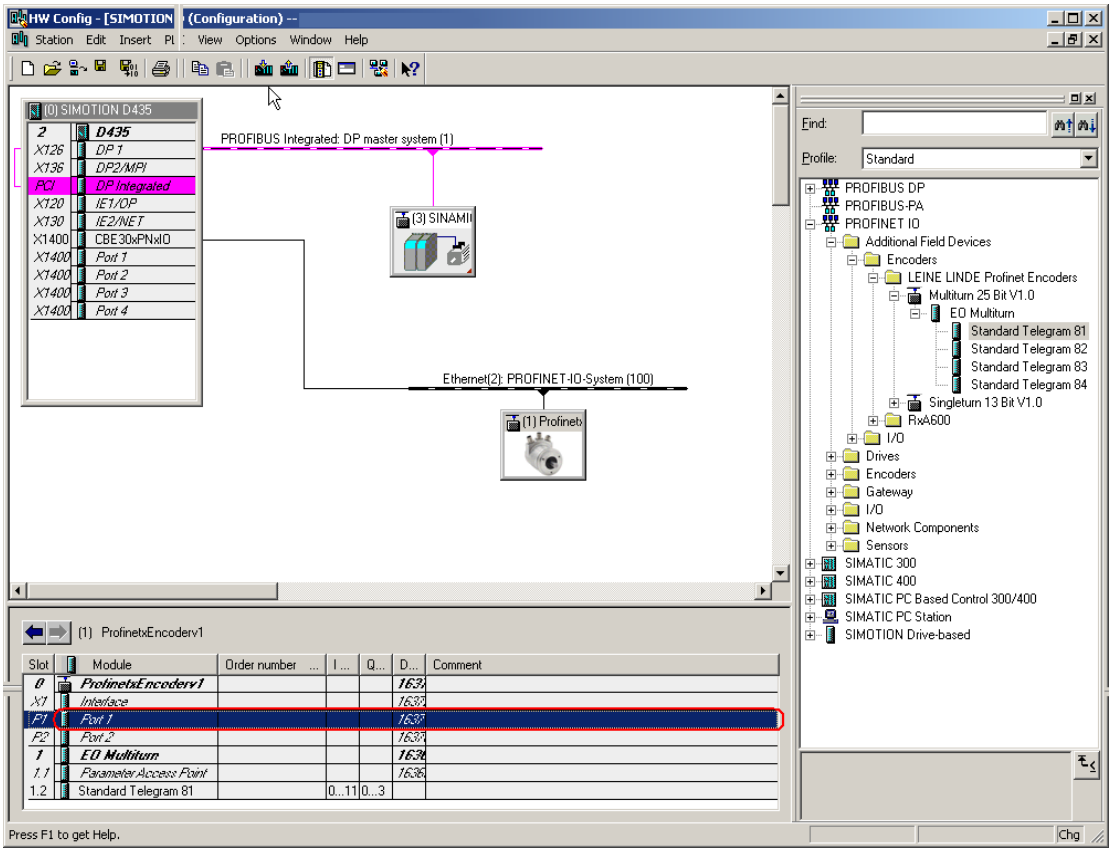


Under the “IO Cycle” tab change the Update Time Mode to “fixed factor”.

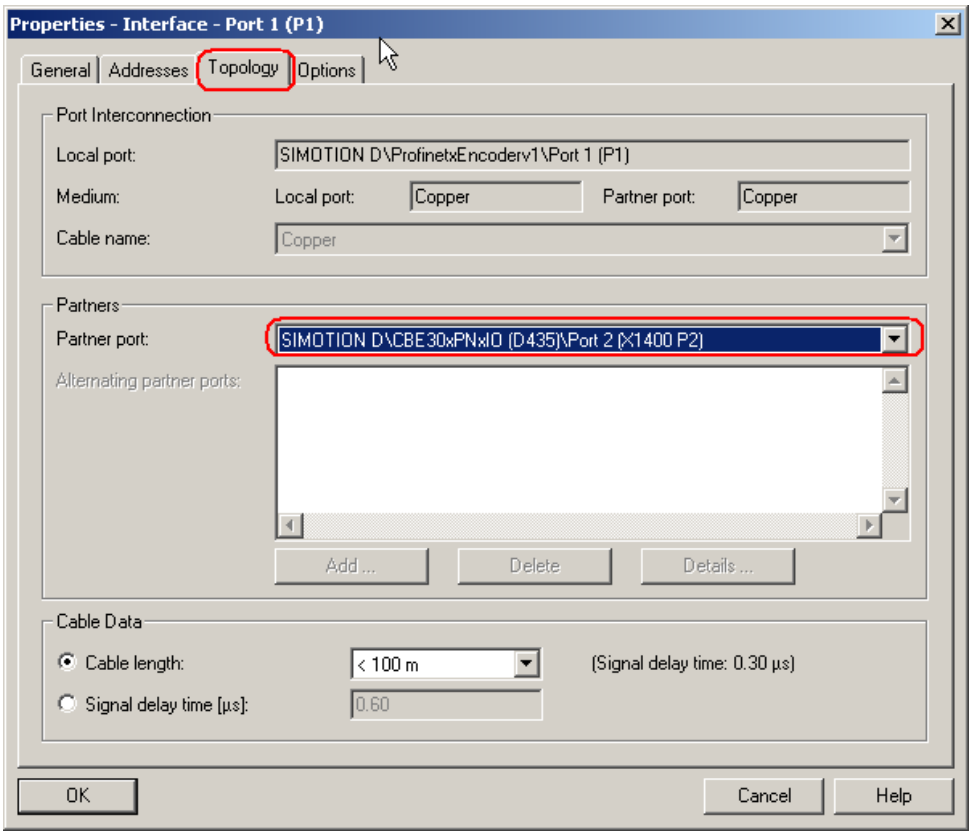


Before the encoder can operate in IRT mode it is necessary to set from which port of the encoder the connection to the network has been done.

To set the topology double click on the port from which the encoder is connected to the network. This is either slot 0 sub slot P1 or slot 0 sub slot P2. In the example below Port 1 is used on the encoder. For port description of the encoder refer to chapter 4 Mechanical installation.

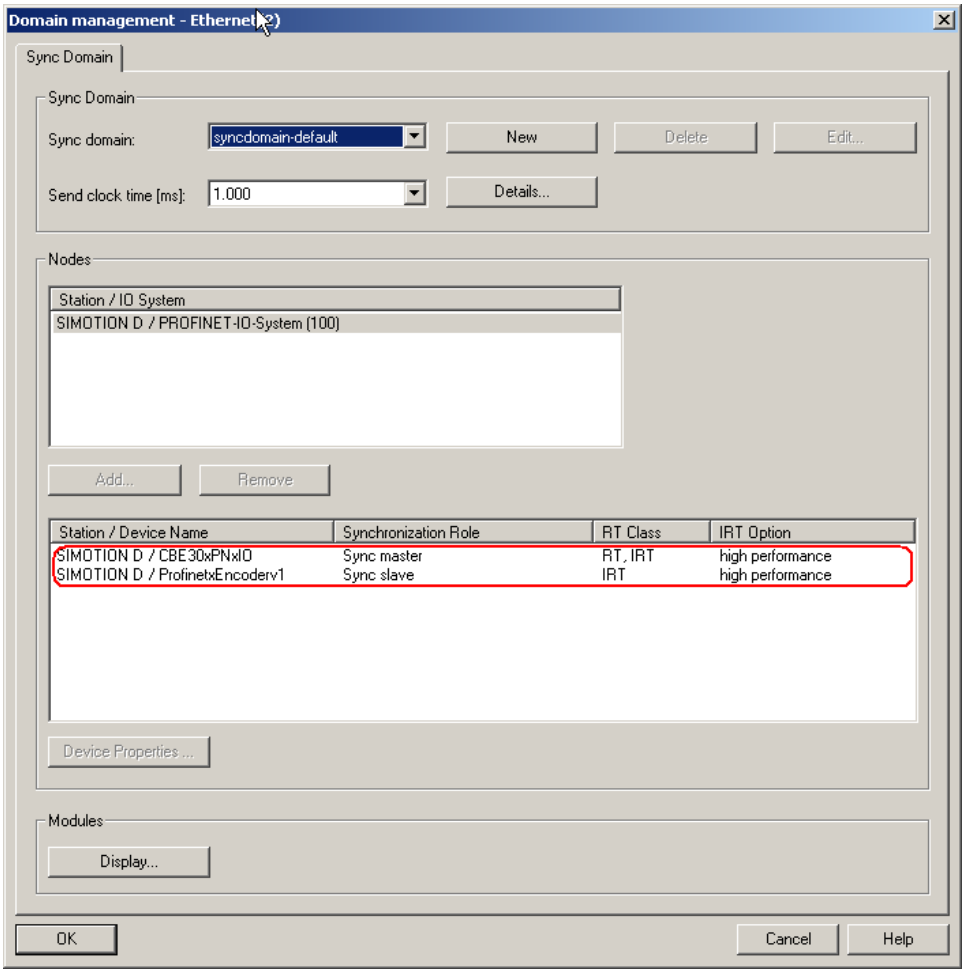


Under the “Topology” tab change the “Partner port:” to the used port of your IO controller.



When the above steps have been performed, it is recommended to verify that the setting for the encoder and the IO controller is correct. This is done by opening the “Domain management” Window found under Edit->PROFINET IO.

Verify that the RT Class is set to IRT and that the IRT option is set to High performance.



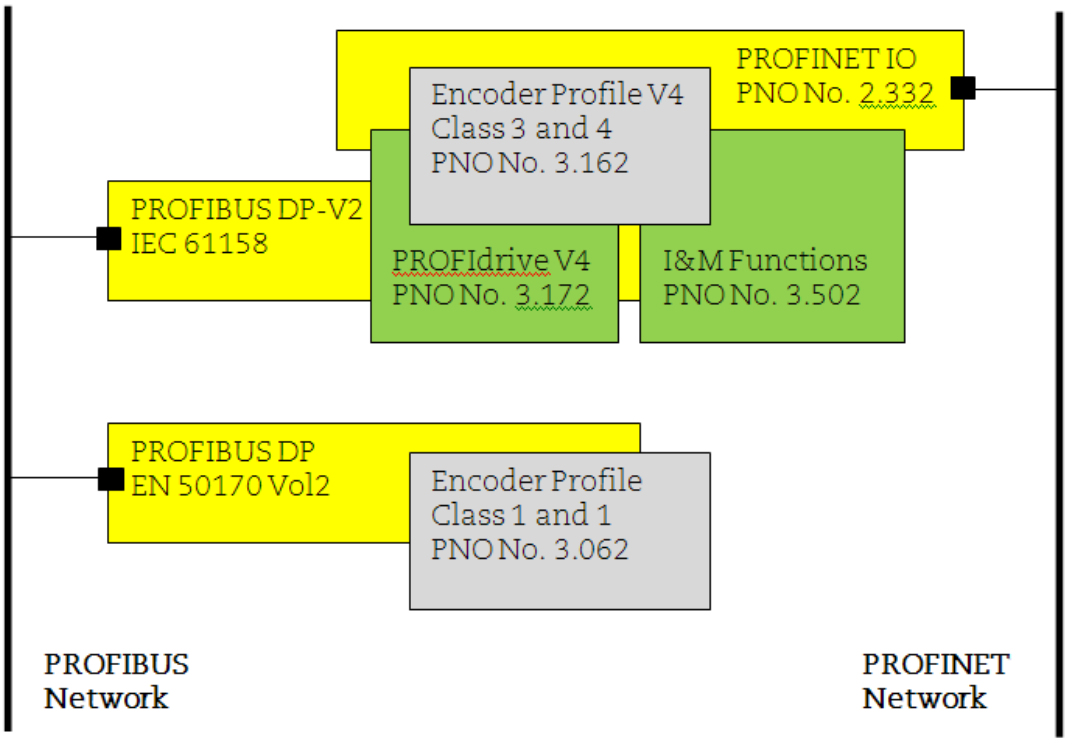
The encoder is now prepared for operating in IRT mode.

6. PROFINET IO data description

6.1 Encoder Profile overview, PNO order no. 3.162

This manual is related to encoder that fulfills the demands and functionality according to encoder profile V4.1 (PNO no 3.162). The operating functions for encoders according to this profile are divided into two application classes, named Class 3 and Class 4. For an overview of the different encoder profile for PROFIBUS and PROFINET and the related standards, see picture below.

For further information regarding the encoder functionality refer to the device profile. The profile and PROFINET technical information can be ordered at PNO in Karlsruhe, Germany (www.profinet.com).



6.2 Application Class definition

Leine & Linde's PROFINET encoders can be configured as a class 3 or class 4 PROFINET IO-device according to the encoder profile V.4.1 (PNO no 3.162). A Class 4 configured encoder from Leine & Linde fully supports all functionality according to the encoder profile V4.1 (3.162).

CLASS 3 Encoder with base mode parameter access and limited parameterization of the encoder functionality. Isochronous mode **is not** supported.

CLASS 4 Encoder with scaling, Preset and base mode parameter access. Isochronous mode **is** supported.

6.3 Standard signals

The table below describes the standard signals that are used to configure the IO data. The signals are described in the chapters that follow.

Significance	Abbreviation	Length (bits)	Data type
Velocity value A	NIST_A	16	Signed
Velocity value B	NIST_B	32	Signed
Control word	G1_STW	16	Unsigned
Status word	G1_ZSW	16	Unsigned
Position value 1	G1_XIST 1	32	Unsigned
Position value 2	G1_XIST2	32	Unsigned
Position value 3	G1_XIST3	64	Unsigned
Control word 2	STW2_ENC	16	Unsigned
Status word 2	ZSW2_ENC	16	Unsigned

6.4 Standard telegrams

Configuration of PROFINET encoders are made by choosing different telegram structures. The telegrams are used to specify the data length and which type of data that are sent to and from the IO-controller. Leine & Linde's PROFINET encoders support the following telegrams.

Standard Telegram 81:

Standard telegram 81 uses 4 bytes for output data from the IO-controller to the encoder and 12 bytes of input data from the encoder to the IO-controller.

Output data from the IO-controller:
2 bytes "Control word 2" (STW2_ENC).
2 bytes "Control word" (G1_STW).

IO Data	1	2
Set point	STW2_ENC	G1_STW

Output data from IO-Controller

Input data to the IO-controller:
2 bytes "Status word 2" (ZSW2_ENC).
2 bytes "Status word" (G1_ZSW).
4 bytes "Position value 1" (G1_XIST1).
4 bytes "Position value 2" (G1_XIST2).

IO Data	1	2	3	4	5	6
Actual value	ZSW2_ENC	G1_ZSW	G1_XIST1		G1_XIST2	

Input data to IO-Controller

Standard Telegram 82:

Standard telegram 82 uses 4 bytes for output data from the controller to the encoder and 14 bytes of input data from the encoder to the controller.

Output data from the IO-controller:
2 bytes "Control word 2" (STW2_ENC).
2 bytes "Control word" (G1_STW).

IO Data	1	2
Set point	STW2_ENC	G1_STW

Output data from IO-Controller

Input data to the IO-controller:
2 bytes "Status word 2" (ZSW2_ENC).
2 bytes "Status word" (G1_ZSW).
4 bytes "Position value 1" (G1_XIST1).
4 bytes "position value 2" (G1_XIST2).
2 bytes "Velocity value A" (NIST_A).

IO Data	1	2	3	4	5	6	7
Actual value	ZSW2_ENC	G1_ZSW	G1_XIST1		G1_XIST2		NIST_A

Input data to IO-controller

Standard Telegram 83:

Standard telegram 83 uses 4 bytes for output data from the controller to the encoder and 16 bytes of input data from the encoder to the controller.

Output data from the IO-controller:
2 bytes “Control word 2” (STW2_ENC).
2 bytes “Control word” (G1_STW).

IO Data	1	2
Set point	STW2_ENC	G1_STW

Output data from IO-controller

Input data to the IO-controller:
2 bytes “Status word 2” (ZSW2_ENC).
2 bytes “Status word” (G1_ZSW).
4 bytes “Position value 1” (G1_XIST1).
4 bytes “Position value 2” (G1_XIST2).
4 bytes “Velocity value B” (NIST_B).

IO Data	1	2	3	4	5	6	7	8
Actual value	ZSW2_ENC	G1_ZSW	G1_XIST1		G1_XIST2		NIST_B	

Input data to IO-controller

Standard Telegram 84:

Standard telegram 84 uses 4 bytes for output data from the controller to the encoder and 20 bytes of input data from the encoder to the controller.

Output data from the IO-controller:
2 bytes “Control word 2” (STW2_ENC).
2 bytes “Control word” (G1_STW).

IO Data	1	2
Set point	STW2_ENC	G1_STW

Output data from IO-controller

Input data to the IO-controller:
2 bytes “Status word 2” (ZSW2_ENC).
2 bytes “Status word” (G1_ZSW).
8 bytes “Position value 3” (G1_XIST3).
4 bytes “Position value 2” (G1_XIST2).
4 bytes “Velocity value B” (NIST_B).

IO Data	1	2	3	4	5	6	7	8	9	10
Actual value	ZSW2_ENC	G1_ZSW	G1_XIST3				G1_XIST2		NIST_B	

Input data to IO-controller

Note: In standard telegram 84, G1_XIST2 is used to transfer error codes and optionally position values if the measuring length exceeds 64 bits.

6.5 Format of G1_XIST1 and G1_XIST2

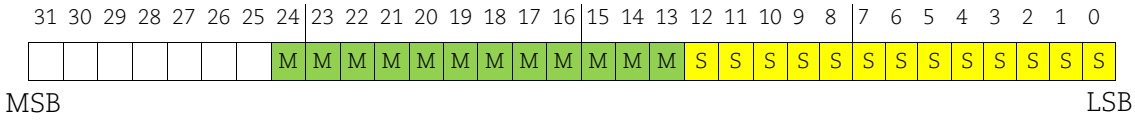
The G1_XIST1 and G1_XIST2 signals consist of the absolute position value in binary format. By default the G1_XIST 1 signal is equal to the G1_XIST2 signal. The format of the actual position values in G1_XIST1 and G1_XIST2 is shown below.

Format definition for G1_XIST1 and G1_XIST2:

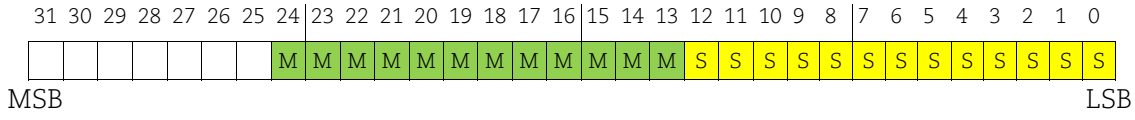
- All values are presented in binary format
- The shift factor is always zero (right aligned value) for both G1_XIST1 and G1_XIST2.
- The setting in the encoder parameter data affects the position value in both G1_XIST1 and G1_XIST2.
- G1_XIST2 displays the error telegram instead of the position value if error occurs.

Example: 25 bit multi turn absolute encoder (8192 steps per revolution, 4096 distinguishable revolutions)

M = Multi turn value (Distinguishable revolutions)
S = Single turn value (number of steps per revolutions)



Absolute value in G1_XIST1



Absolute value in G1_XIST2

6.6 Format of G1_XIST3

G1_XIST3 is a 64 bit position value which is used to support encoders with a resolution exceeding 32 bits.

Format definition for G1_XIST3:

- Binary format
- The actual position value is always right aligned, a shifting factor is not used.
- The settings in the encoder parameter data affect the position value in G1_XIST3 if Class 4 is enabled.

IO Data	1	2	3	4
Format	64 bit position value			

6.7 Control word 2 (STW2_ENC)

The control word 2 (ZSW2_ENC) is referred to as the “master sign of life” and it includes the fault buffer handling and Control by PLC mechanism from PROFIdrive

STW1 and the Controller Sign-Of-Life mechanism from PROFIdrive STW2. This signal is mandatory for controlling the clock synchronization.

Bit	Function
0…6	Reserved
7	Fault Acknowledge
8, 9	Reserved
10	Control by PLC
11	Reserved
12…15	Controller Sign-Of-Life

STW2_ENC definition and implementation requirements

Bit	Value	Significance	Comments
7	1	Fault Acknowledge (0->1)	The fault signal is acknowledged with a positive edge. The encoder reaction to a fault depends on the type of fault.
	0	No significance	
10	1	Control by PLC	Control via interface, EO IO Data is valid.
	0	No Control by PLC	EO IO Data not valid, except Sign-Of-Life
12..15		Controller Sign-Of-Life	

Detailed assignment of the encoder control word 2 (STW2_ENC)

6.8 Status word 2 (ZSW2_ENC)

The status word 2 (ZSW2_ENC) is referred to as the “slave’s sign of life” and it includes the fault buffer handling and Control by PLC mechanism from PROFIdrive ZSW1 and the Slave Sign-Of-Life mechanism from PROFIdrive ZSW2. This signal is mandatory for controlling the clock synchronization.

Bit	Function
0…2	Reserved
3	Fault Present / No Fault
4…8	Reserved
9	Control requested
10, 11	Reserved
12…15	Encoder Sign-Of-Life

ZSW2_ENC definition and implementation requirements

Bit	Value	Significance	Comments
3	1	Fault Present	Unacknowledged faults or currently not acknowledged faults (fault messages) are present (in the buffer).The fault reaction is fault-specific and device-specific. The acknowledging of a fault may only be successful, if the fault cause has disappeared or has been removed before. If the fault has been removed the encoder returns to operation. The related fault numbers are in the fault buffer.

	0	No Fault	
9	1	Control requested	The automation system is requested to assume control.
	0	No Control requested	Control by automation system is not possible, only possible at the device or by another interface.
12..15		Encoder Sign-Of-Life	

Detailed assignment of the encoder status word 2 (ZSW2_ENC)

6.9 Control word (G1_STW)

The control word controls the functionality of major encoder functions.

Bit	Function
0…7	Function requests: Reference mark search, measurement on the fly
8…10	Reserved (without effect)
11	Home position mode
12	Request set/shift of home position (Preset)
13	Request absolute value cyclically
14	Activate parking sensor
15	Acknowledging a sensor error

G1_STW implementation requirements

Note: If the sensor parking is activated (bit 14 = 1) the encoder is still on the bus with the slave sign of life active and the encoder error and diagnostics switched off.

6.10 Status word (G1_ZSW)

The status word defines encoder states, acknowledgements, error messages of major encoder functions.

Bit	Function
0…7	Function status: Reference mark search, measurement on the fly
8	Probe 1 deflected
9	Probe 2 deflected
10	Reserved, set to zero
11	Requirement of error acknowledgement detected
12	Set /shift of home position executed
13	Transmit absolute value cyclically
14	Parking sensor active
15	Sensor error

G1_ZSW implementation requirements

Note: If bit 13 ”Transmit absolute value cyclically” or bit 15 “Sensor error” is not set there is no valid value or error code transferred in G1_XIST2.

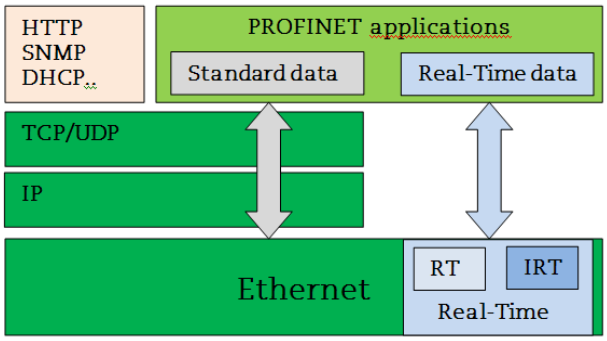
Note: Bit 13 ”Transmit absolute value cyclically” cannot be set at the same time as bit 15 “Sensor error” as these bits are used to indicate either a valid position value transmission (bit 13) or the error code transmission (bit 15) in G1_XIST2.

6.11 Real Time Communication

PROFINET IO uses three different communication channels to exchange data with programmable controllers and other devices. The non real time channel based on for example TCP (UDP)/IP is used for parameterization, configuration and acyclic read/write operations.

The RT or Real Time channel is used for process data transfer and alarms. Real-time data are treated with a higher priority than data sent over the open channel. RT communications overrides the open channel to handle the data exchange with programmable Controllers.

The third channel, Isochronous Real Time (IRT) is the high performance, high speed channel used for demanding motion Control applications. IRT data are treated with a higher priority than RT data sent over the RT channel.



PROFINET distinguishes between three real time classes for transmission of time critical process data. The three RT classes are:

Real-Time, RT Class 1

- Unsynchronized Real time communication
- Industrial standard switches can be used.
- Typical application area: Factory automation

Real-Time, RT Class 2

- Synchronized and unsynchronized data transmission
- Special switches supporting IRT is needed
- Typical application area: Factory automation

Isochronous Real Time, RT Class 3

The isochronous operation mode is used when real-time positioning with high performance is required. The basic principal is that all PROFINET devices on the net are clock synchronized with the controller using a global control broadcast enabling simultaneous data accusation from all devices with microsecond accuracy. The data exchange cycles for IRT are usually in the range of a few hundred microseconds up to a few milliseconds. The difference to real-time communication is essentially the high degree of determinism, so that the start of a bus cycle is maintained with high precision. The synchronization is monitored by “sign-of life” messages in “Control word 2” (STW2_ENC) and “Status word 2” (ZSW2_ENC).

- Clock synchronized data transmission
- Special switches supporting IRT is needed
- IRT is required for example motion control applications

7. Alarms and warnings

7.1 Diagnostics and Alarms

Diagnostic data is always transferred acyclically using Record Data communications over the non real time channel. An IO-Supervisor must specifically request the diagnostic or status data from the IO-device using RDO (Record Data Object) services.

Alarm data is transmitted from the IO-device to the IO-controller via the RT channel. Alarm is generated by the encoder when failure occurs which effects the position value. Alarms can be reset (deleted) when all encoder parameters are within the specified value ranges and the position value is correct.

7.2 Channel diagnostics

The encoder outputs a diagnostic interrupt to the CPU when it detects one of the supported channel diagnostics.

Supported channel diagnostic	Diagnostic data record	Description
Position error	0x900A	The encoder fails to read the correct position value
Memory error	0x9000	The encoder fails to read stored offset or preset values from the non volatile memory
Commissioning diagnostics	0x9011	User parameter data assignment error

In a Simatic STEP 7 system the operation system responds by calling a diagnostic OB. The OB number and start information provides the cause and location of the error. The error information can be read by calling a system Function block (SFB54 “RALRM” for STEP 7). Then the user can decide how the system should handle the error.

Note: If the called OB is not included in the program the CPU will go to stop.

7.3 Sensor status word

Diagnosis information can be obtained by monitoring of the Error bit in the Sensor Status word G1_ZSW (bit 15) and evaluation of the error code transmitted in G1_XIST2.

Supported diagnostic	Error code in G1_XIST2	Description
Sensor group error	0x0001	The encoder fails to read the correct position value
Memory error	0x1001	The encoder fails to read stored offset or preset values from the non volatile memory
Command not supported	0x0F01	User parameter data assignment error or command error in commands words G1_STW and STW2_ENC
Master´s sign of life fault	0x0F02	The number of permissible failures the controller's life sign was exceeded.

8 Acyclic Parameter Data

8.1 Acyclic data exchange

In addition to the cyclic data exchange, the PROFINET encoder also supports acyclic data exchange. The acyclic data exchange is transferred over the non-real time channel and is used to read out and write status information from and to the IO-device. The acyclic data exchange is conducted in parallel to the cyclic data communication.

Example of acyclic data:

- Reading of diagnostic
- Reading of I&M functions
- Reading of PROFIdrive parameters

8.2 Identification and Maintenance (I&M functions)

Encoders according to the encoder profile 3.162 also support I&M functionality. The main purpose of the I&M functions is to support the end user if the device is acting faulty or missing some of its functionality. The I&M functions could be seen as an electronic nameplate containing common information regarding the device and its manufacturer.

According to the PROFINET specification all IO-devices must at least support the following I&M functions:

- Order ID
- MAC address
- Hardware Version
- Software Version
- Product type
- Manufacturer ID

For more information regarding additional I&M functions supported by Leine & Linde encoders, refer to chapter 9.14.6.

8.3 Base Mode Parameter access

8.3.1 General characteristics

Acyclic parameter can be transmitted 1(single) or up to 39(multi) in one access. A parameter access can be up to 240 bytes long.

8.3.2 Parameter requests and responses

Request header: Request ID, DO-ID and number of parameters of the access.

Parameter address: One address for each parameter, if several parameters are accessed.

Parameter value: If the Request ID is 0x02 (change value) the value is set in the request and if the Request ID is 0x01 (request value), the value appears in the reply.

8.3.4 Changing the preset value

The table below shows the structure of a change value request.

Write of Preset value, parameter 65000 Parameter request		
Request reference	0x00	
Request ID	0x02	0x02 →Change value, 0x01→read value
DO-ID (axis)	0x01	Drive Object ID
No of parameters	0x01	
Attribute	0x10	0x10→Value
No of elements	0x00	
Parameter number	0xFDE8	Parameter 65000
Sub index	0x0000	
Format	0x04	Data type integer 32
Number of values	0x01	

8.3.5 Reading the preset value

The tables below show the structure of a read value request.

Read of Preset value, parameter 65000 Parameter request		
Request reference	0x00	
Request ID	0x01	0x01→read value
DO-ID (axis)	0x01	Drive Object ID
No of parameters	0x01	0x01 Read one parameter
Attribute	0x10	0x10→Value
No of elements	0x00	
Parameter number	0xFDE8	Parameter 65000
Sub index	0x0000	

Read of Preset value, parameter 65000 Parameter response		
Request reference	0x00	mirrored
Response ID	0x01	0x01→read value
DO-ID (axis)	0x01	mirrored
No of parameters	0x01	
Format	0x04	0x04= Data type unsigned 32
No of values	0x01	
Values or errors	0x00,0x00,0x00,0x64	Preset value 100

8.4 Supported parameters

8.4.1 Parameter 922, read only

922→ unsigned int, presents which telegram is used. Telegram 81,82,83 or 84 is possible.

8.4.2 Parameter 925, read/write

925→ unsigned int, maximum allowed MLS (Master sign-of-life) error. Parameter 925 may be used to set a maximum on how many consecutive Sign-of-life failures may occur.

8.4.3 Parameter 964, read only

964→unsigned int

964[0] = Manufacturer Id. This is set during manufacturing of the encoder.
964[1] = 0→DU Drive unit type, always set to 0.
964[2] = 201→Software version
964[3] = 2009→Software year
964[4] = 2805→ Software day and month
964[5] = 1→ Number of drive objects (DO)

8.4.4 Parameter 965, read only

965→OctetString 2

965[0] =0x3D→Encoder profile number

965[1] = 31 or 41 →Encoder profile version, set by customer (user_parameters)

8.4.5 Parameter 971, read/write

971→ unsigned int, Store the local parameter set to a non volatile memory. Preset value is saved when writing value 1 and is set to 0 by the encoder firmware when finished. This means that the preset value has been saved when reading back value 0.

8.4.6 Parameter 974, read only

974→unsigned int

974[0] = 96→Max array length supported by parameter channel.
974[1] = 1→Numbers of multi parameters, 1 = no support of multi parameters.
974[2] = 1000→max time to process parameter request, n x 10 ms.

8.4.7 Parameter 975, read only

975→unsigned int

975[0] = Manufacturer Id, Set in the production.
975[1] = 7011→DO type
975[2] = 201→Software version
975[3] = 2009→Software year
975[4] = 2805→Software day and month
975[5] = 0x0005→ Profidrive DO type class 5 = encoder interface
975[6] = 0x8000→ Profidrive SUB class 1, Encoder application class 4 supported.
975[7] = 0x0001→Drive object Id (DO ID).

8.4.8 Parameter 979, read only

979→unsigned long

979[0] = 0x00005111→ Number of index describing encoder, Numbers of described encoders, Version of parameter structure

979[1] = 0x80000000→ Sensor type
Bit 31 = 1 if configuration and parameterization is OK
Bit 0 = 0 Rotary encoder, Bit 0 = 1 linear encoder
Bit 1 = 0 always set to 0
Bit 2 = 0 →32 bit data, Bit 2 = 1 →64 bit data

979[2] = 8192 → Encoder scaled resolution
979[3] = 0 →Shift factor for G1_XIST1. Always set to 0.
979[4] = 0 →Shift factor for G1_XIST2. Always set to 0.
979[5] = 1 or 4096 →Singleturn = 1, Multiturn = 4096
979[6] = 0
979[7] = 0
979[8] = 0
979[9] = 0
979[10] = 0

8.4.9 Parameter 980, read only

This parameter shows the supported parameters

980→unsigned int

980[0] = 922	980[8] = 61000	980[16] = 65003
980[1] = 925	980[9] = 61001	980[17] = 0
980[2] = 964	980[10] = 61002	
980[3] = 965	980[11] = 61003	
980[4] = 971	980[12] = 61004	
980[5] = 974	980[13] = 65000	
980[6] = 975	980[14] = 65001	
980[7] = 979	980[15] = 65002	

8.4.10 Parameter 61000, read/write

Name of station

61000 →OctetString, 240 octets

8.4.11 Parameter 61001, read only

IP of station
61001→unsigned long

8.4.12 Parameter 61002, read only

MAC of station
61002→OctetString, 6 octets

8.4.13 Parameter 61003, read only

Default gateway of station
61003→ unsigned long

8.4.14 Parameter 61004, read only

Subnet mask of station
61004→ unsigned long

8.4.15 Parameter 65000, read/write

Used with telegram 81-83
65000→ signed long, preset value 32 bit.

8.4.16 Parameter 65001, read only

Used with telegram 81-84
65001→ unsigned long

65001[0] = 0x000C0101 →Header, Version of parameter structure and numbers of index describing the encoder. 12 index and version 1.01
65001[1] = Operating status (Bit 4 alarm channel control is always set with profile version 4.x)
65001[2] = Alarm
65001[3] = Supported alarms
65001[4] = Warning
65001[5] = Warnings supported
65001[6] = 0x00000401→ Encoder profile version. Always set to this value.

65001[7] = Operating time
65001[8] = Offset value
65001[9] = Singleturn value, scaled value
65001[10] = Total measuring length, scaled value (Linear = 1)
65001[11] = Velocity unit

- step/10 ms
- step/100 ms
- step/1000 ms
- RPM

8.4.17 Parameter 65002, read/write

Used with telegram 84
65002→ signed long long, Preset value 64 bit.

8.4.18 Parameter 65003, read only

Used with telegram 84
65003→ unsigned long long,

65003[0] = 0x0000000000040101→Header Version of parameter structure and numbers of index describing encoder. 4 index and version 1.01
65003[1] = Offset value 64 bit
65003[2] = Singleturn value 64 bit, scaled value
65003[3] = total measuring range in measuring units 64 bit, scaled value (Linear =1)

8.5 Example of reading and writing to a parameter

This is an example of S7 blocks used for reading and writing to parameter 65000 (preset value). Experience with S7 programming and Statement List programming language STL is required.

Hardware components		
IO Controller	SIEMENS S7-F CPU	CPU 315F-2 PN/DP
IO Device	Leine & Linde PROFINET encoder	

Software components	
SIMATIC STEP 7	V5.4 +SP5
GSDML file for PROFINET encoder	GSDML V2.2-LL-Profinet-encoder-20100225

8.5.1 Used blocs

Write record block SFB53 “WRREC”
Read record block SFB52 “RDREC”
Instance data blocks DB3 and DB4
Request data block DB1
Response data block DB2
Organization blocks OB1, OB82 and OB86

SFB52
SFB52 is standard S7 block for reading parameters.

SFB53
SFB53 is standard S7 block for writing parameters.

DB1

DB1 is the request data block.

Address	Name	Type	Initial value	Actual value	Comment
0.0	Request_reference	BYTE	B#16#1	B#16#01	request number
1.0	Request_ID	BYTE	B#16#2	B#16#02	request parameter = 1; change parameter = 2
2.0	Axis	BYTE	B#16#0	B#16#00	Axis addressing for multi-axis drives
3.0	No_of_parameters	BYTE	B#16#1	B#16#01	write 1 parameters
4.0	Attribute_parameter_01	BYTE	B#16#10	B#16#10	write value
5.0	No_of_elements_01	BYTE	B#16#1	B#16#01	number of elements 1
6.0	parameter_number_01	WORD	W#16#FDE8	W#16#FDE8	parameter 65000 (Preset value 32)
8.0	Subindex_01	WORD	W#16#0	W#16#0000	subindex
10.0	Data_type	BYTE	B#16#4	B#16#04	data type integer 32
11.0	No_of_values	BYTE	B#16#1	B#16#01	Number of values = number of elements
12.0	Value	DINT	L#0	L#33554176	Value Of 65000

DB2

DB2 is the response data block.

Address	Name	Type	Initial value	Comment
0.0		STRUCT		
+0.0	Request_reference_mirror	BYTE	B#16#0	request number mirrored
+1.0	Response_ID	BYTE	B#16#0	request parameter
+2.0	DOID_mirrored	BYTE	B#16#0	Axis mirrored
+3.0	No_of_parameters	BYTE	B#16#0	response about number of parameter
+4.0	Format_parameter_1	BYTE	B#16#0	response about parameter 1 format
+5.0	No_of_values_parameter_1	BYTE	B#16#0	response about number of value of parameter 1
+6.0	parameter_number_01	DWORD	DW#16#0	Read value p65000
=10.0		END_STRUCT		

DB3

DB3 is the instance data block of SFB52

DB3 -- PN_WR_RD_PRESET_LL\SIMATIC 300(1)\CPU 315F-2PN/DP

	Address	Declaration	Name	Type	Initial value	Actual value	Comment
1	0.0	in	REQ	BOOL	FALSE	FALSE	
2	2.0	in	ID	DWORD	DW#16#0	DW#16#0	
3	6.0	in	INDEX	INT	0	0	
4	8.0	in	MLEN	INT	0	0	
5	10.0	out	VALID	BOOL	FALSE	FALSE	
6	10.1	out	BUSY	BOOL	FALSE	FALSE	
7	10.2	out	ERROR	BOOL	FALSE	FALSE	
8	12.0	out	STATUS	DWORD	DW#16#0	DW#16#0	
9	16.0	out	LEN	INT	0	0	
10	18.0	in_out	RECORD	ANY	P#P 0.0 VOID 0	P#P 0.0 VOID 0	

DB4

DB4 is the instance data block of SFB53

DB4 -- PN_WR_RD_PRESET_LL\SIMATIC 300(1)\CPU 315F-2PN/DP

	Address	Declaration	Name	Type	Initial value	Actual value	Comment
1	0.0	in	REQ	BOOL	FALSE	FALSE	
2	2.0	in	ID	DWORD	DW#16#0	DW#16#0	
3	6.0	in	INDEX	INT	0	0	
4	8.0	in	LEN	INT	0	0	
5	10.0	out	DONE	BOOL	FALSE	FALSE	
6	10.1	out	BUSY	BOOL	FALSE	FALSE	
7	10.2	out	ERROR	BOOL	FALSE	FALSE	
8	12.0	out	STATUS	DWORD	DW#16#0	DW#16#0	
9	16.0	in_out	RECORD	ANY	P#P 0.0 VOID 0	P#P 0.0 VOID 0	

OB1

OB1 controls the read and write operation.

```
OB1 : "Main Program Sweep (Cycle)"
In network 1 and network 2 the user will see how to generate the request /
response DB for writing/reading p65000 using S7 standard function blocks
SFB53/53
easy handled by the VAT_1 vaiable table.
Network 1: Write request
With the SFB53 "WRREC" (write record) you transfer a data record with the
number INDEX to a DP slave device component defined by ID.
      A     M      8.4
      AN    M      8.1
      AN    M      8.3
      AN    M      8.2
      S     M      8.0
      L     W#16#B02E
      T     #INDEX

      CALL  "WRREC" , "InstanceDB_SFB53"    SFB53 / DB4        -- Write a Process Data Record
       REQ   :=M8.0
       ID    :=DW#16#7F7
       INDEX :=#INDEX
       LEN   :=16
       DONE  :=M14.0
       BUSY  :=M8.1
       ERROR :=M14.2
       STATUS:=MD10
       RECORD:=P#DB1.DBX0.0 BYTE 16


      A     M      8.1
      R     M      8.0

Network 2: Read request
With the SFB52 "RDREC" (read record) you read a data record with the number
INDEX from a component.
      A     M      8.4
      AN    M      8.1
      AN    M      8.3
      AN    M      8.0
      S     M      8.2

      CALL  "RDREC" , "InstanceDB_SFB52"    SFB52 / DB3        -- Read a Process Data Record
       REQ   :=M8.2
       ID    :=DW#16#7F7
       INDEX :=#INDEX
       MLEN  :=10
       VALID :=M16.0
       BUSY  :=M8.3
       ERROR :=M16.2
       STATUS:=MD18
       LEN   :=MW22
       RECORD:=P#DB2.DBX0.0 BYTE 10


      A     M      8.3
      R     M      8.2
```

Parameters of SFB52

Parameter	Declaration	Data type	Description
REQ	INPUT	BOOL	REQ=1 Enables data transfer
ID	INPUT	DWORD	Logical address of the PROFINET IO module or sub module (PAP-module address 2039)
INDEX*	INPUT	INT	Record number
MLEN*	INPUT	INT	Maximum length of the record information in bytes
VALID	OUTPUT	BOOL	New record has been received and is valid.
BUSY	OUTPUT	BOOL	Busy=1 during the read operation
ERROR	OUTPUT	BOOL	Error =1 read error
STATUS	OUTPUT	DWORD	Block status or error code
LEN*	OUTPUT	INT	Length of record information
RECORD	IN_OUT	ANY	Target area for the record

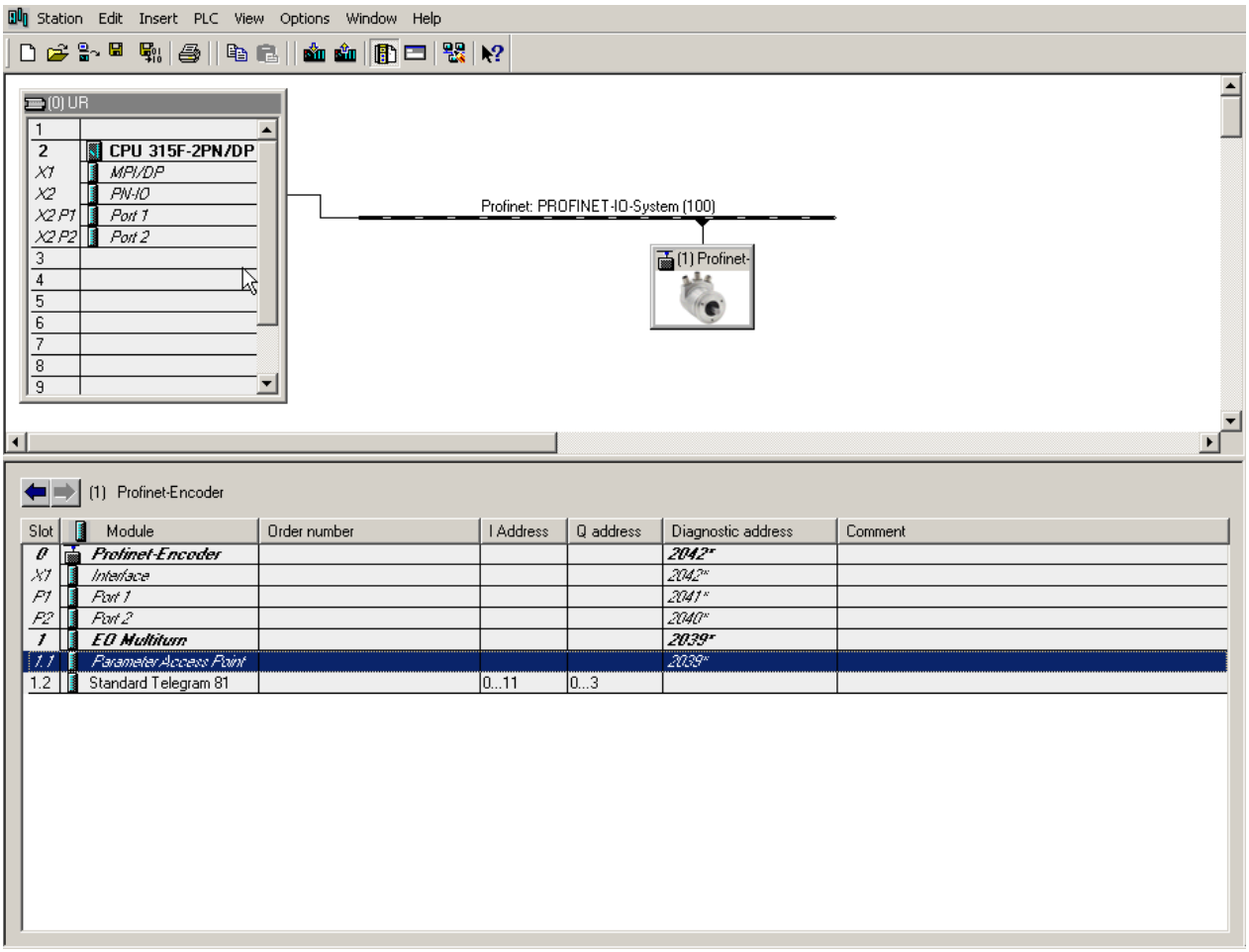
*) Negative values are interpreted as 16-bit unsigned integers.

Parameters of SFB53

Parameter	Declaration	Data type	Description
REQ	INPUT	BOOL	REQ=1 Enables data transfer
ID	INPUT	DWORD	Logical address of the PROFINET IO module or sub module (PAP-module address 2039)
INDEX*	INPUT	INT	Record number
LEN*	INPUT	INT	Length of the record information in bytes
DONE	OUTPUT	BOOL	Data record was transferred
BUSY	OUTPUT	BOOL	Busy=1 during the write operation
ERROR	OUTPUT	BOOL	Error =1 write error
STATUS	OUTPUT	DWORD	Block status or error code
RECORD	IN_OUT	ANY	Data record

*) Negative values are interpreted as 16-bit unsigned integers.

Parameter Access point address from HW Configuration



Variable table

With the variable table the user can monitor and modify variables.

	Address	Symbol	Symbol comment	Display format	Status value	Modify value
1	// Enable parameter write/read 1=enabled					
2	M 8.4			BOOL	false	
3						
4	// The flag M8.1 shows if writing is not yet completed (BUSY = 1: The write process is not yet terminated)					
5	M 8.1			BOOL	false	
6	// ERROR = 1: A write error has occurred					
7	M 14.2			BOOL	false	
8	// Write block status or error information					
9	MD 10			HEX	DW#16#00700000	
10						
11	// The flag M8.3 shows if reading is not yet completed (BUSY = 1: The read process is not yet terminated)					
12	M 8.3			BOOL	false	
13	// ERROR = 1: A read error has occured					
14	M 16.2			BOOL	false	
15	// Read block status or error information					
16	MD 18			HEX	DW#16#00700000	
17						
18	// Position and control/status words					
19	PIW 2			HEX	W#16#0000	
20	PQW 2			HEX		W#16#1000
21	PIW 1			HEX	W#16#0000	
22	PQW 1			HEX		W#16#0400
23						
24	PID 4			HEX	DW#16#0001877E	
25	PID 8			HEX	DW#16#0001877E	
26						
27						
28						
29	// Write parameters:					
30	DB1.DBB 1	"Request_DB".Request_ID	request parameter = 1; change parameter = 2	HEX	B#16#02	
31	DB1.DBD 12	"Request_DB".Value	Write value 65000	HEX	DW#16#12345678	DW#16#12345678
32	DB2.DBD 6	"Respons_DB".parameter_number_01	Read value p65000	HEX	DW#16#00000000	
33						

9.Functional description of Leine & Linde encoder

This chapter describes the functions that have been implemented in PROFINET encoders from Leine & Linde. The table below shows the supported functions in a Leine & Linde PROFINET encoder.

Function
Code sequence
Class 4 functionality
G1_XIST1 Preset control
Scaling function control
Alarm channel control
Compatibility mode
Preset value
Preset value 64 bit
Measuring units per revolution / Measuring step
Total measuring range
Measuring units per revolution 64 bit
Total measuring range 64 bit
Maximum Master Sign-Of-Life failures
Velocity measuring unit
Encoder Profile version
Operating time
Offset value
Offset value 64 bit

9.1 Code sequence

The code sequence defines whether the absolute position value should increase during clockwise or counter clockwise rotation of the encoder shaft seen from flange side. The code sequence is by default set to increase the absolute position value when the shaft is turned clockwise (0).

Attribute	Meaning	Value
CW	Increasing position values with clockwise rotation (viewed from shaft side)	0
CCW	Increasing position values with counter clockwise rotation (viewed from shaft side)	1

Code sequence attributes

Note: The position value will be affected when the code sequence is changed during operation. It might be necessary to perform a preset after the code sequence has been changed.

9.2 Class 4 functionality

This parameter enables or disables the measuring task functions Scaling, Preset and Code sequence. If the function is enabled, scaling and Code sequence control affects the position value in G1_XIST1, G1_XIST2 and G1_XIST3. A preset will in this case always affect G1_XIST2 and G1_XIST3 but if the parameter “G1_XIST1 Preset control” is disabled the preset will not affect the position value in G1_XIST1.

Attribute	Meaning	Value
Enable	Scaling/preset/code sequence control enabled	1
Disable	Scaling/preset/code sequence control enabled	0

Class 4 functionality attributes

9.3 G1_XIST1 Preset control

This parameter controls the effect of a preset on the G1_XIST1 actual value.
If “Class 4 functionality” is activated and “G1_XIST1 Preset control” is disabled, the position value in G1_XIST1 will not be affected by a Preset.

Attribute	Meaning	Value
Enable	G1_XIST1 is affected by a Preset command	0
Disable	Preset does not affect G1_XIST1	1

G1_XIST1 Preset control attributes

Note: This parameter is disabled by setting the value to 1.

Note: There is no functionality of this parameter if the “Class 4 functionality” parameter is disabled.

9.4 Scaling function control

This parameter enables or disables the Scaling function of the encoder.

Attribute	Meaning	Value
Enable	Scaling function is enabled	1
Disable	Scaling function is disabled	0

Scaling function control attributes

Note: The parameter “Class 4 functionality” must be enabled to use this parameter.

9.5 Alarm channel control

This parameter enables or disables the encoder specific Alarm channel transferred as Channel Related Diagnosis. This functionality is used to limit the amount of data sent in isochronous mode.

If the value is zero (default value) only the communication related alarms are sent via the alarm channel. If the value is one (1) also encoder profile specific faults and warnings are sent via the alarm channel.

Attribute	Meaning	Value
Enable	Profile specific diagnosis is switched on	1
Disable	No Profile specific diagnosis (default)	0

Alarm channel control attributes

Note: This parameter is only supported in compatibility mode.

9.6 Compatibility mode

This parameter defines if the encoder should run in a mode compatible to Version 3.1 of the Encoder Profile. See below for an overview of functions affected when the compatibility mode is enabled.

Attribute	Meaning	Value
Enable	Compatibility with Encoder ProfileV 3.1	1
Disable	No backward compatibility (default)	0

Compatibility mode attributes

Function	Compatibility mode Enable (= 0)	Compatibility mode Disabled (= 1)
Control by PLC (STW2_ENC)	Ignored, the Control word (G1_STW) and set point values are always valid. Control requested (ZSW2_ENC) is not supported and is set to 0.	Supported
User parameter "Maximum" Master Sign-Of-Life failures"	Supported	Not supported, one Sign-Of-Life failure tolerated, PROFIdrive P925 is optional to control the life sign monitoring.
User parameter "Alarm channel control"	Supported	Not supported, the application alarm channel is active and controlled by a PROFIdrive parameter
P965 – Profile Version	31 (V3.1)	41 (V4.1)

Compatibility mode definition

9.7 Preset Value

The preset value function enables adaptation of the position value from the encoder to a known mechanical reference point of the system. The preset function sets the actual position of the encoder to zero (= default value) or to the selected preset value. A preset value can be set more than once and it can be stored to the non-volatile memory using PROFIdrive parameter 971.

The preset function has an absolute and a relative operating mode selectable by bit 11 in the Control word (G1_STW). Bit 11 and bit 12 in the Control word controls the preset in the following way.

Normal operating mode: Bit 12 = 0
In this mode, the encoder will make no change in the output value.

Preset mode absolute: Bit 11 =0, Bit 12 = 1
In this mode, the encoder reads the current position value and calculates an internal offset value from the preset value and the current position value. The position value is then shifted with the calculated offset value to get a position value equal to the preset value. No preset will be made if a negative preset value is used while trying to initiate an absolute preset.

Preset mode relative: **Bit 11 =1, Bit 12 = 1**
In this mode the position value is shifted by the preset value, which could be a negative or a positive value set by encoder parameter 65000 or 65002.

The steps below should be followed by the IO-controller when modifying the Preset value parameters:

1. Read the requested Preset value parameter and check if the returned value meets the application requirements. If not, proceed with the following steps.
2. Write the Preset value into the individual parameter.
3. Store the value in the non –volatile memory by PROFIdrive parameter 971 if the value should be valid also after the next power on sequence.

Parameter	Meaning	Data type
Preset value	The preset value for encoders with a measuring range of maximum 32 bits	Integer 32
Preset value 64 bit	The preset value for encoders with a measuring range exceeding 32 bits	Integer 64

Preset value parameters

Note: **The preset function should only be used at encoder standstill**

Note: **The number of possible preset cycles is unlimited.**

Note: **If scaling is used the preset function shall be used after the scaling function, to ensure that the preset value is entered in the current measuring unit.**

Note: **There is no preset activated when the Preset value is written to the encoder. The preset function is controlled by bits in the control and status words (G1_STW and G1_ZSW) and bit in the operating parameters. The preset value is used when a preset is requested by bit 12 in the Control word (G1_STW).**

9.8 Scaling function parameters

The scaling function converts the encoder's physical absolute position value by means of software in order to change the resolution of the encoder. The scaling parameters will only be activated if the parameter "Class 4 functionality" and "Scaling function control" are enabled. The permissible value range for the scaling is limited by the resolution of the encoder. The scaling parameters are securely stored in the IO-controller and are reloaded into the encoder at each power-up.

9.8.1 Measuring units per revolution

This parameter sets the single turn resolution of the encoder. In other words it is the number of different measuring steps during one revolution of the encoder.

Example: For a 13-bit encoder with a single turn resolution of 13 bits the permissible value range for "Measuring units per revolution" is between 2^0 and 2^{13} (8192).

Parameter	Meaning	Data type
Measuring units per revolution	The single turn resolution in measuring steps	Unsigned 32
Measuring units per revolution 64 bit	The single turn resolution in measuring steps for encoders with a resolution exceeding 32 bits.	Unsigned 64

Single turn scaling parameters

Note: After downloading new scaling parameters, the preset function must be used to set the encoder starting point to absolute position 0 or to any required starting position within the scaled operating range.

9.8.2 Total measuring range

This parameter sets the total measuring range of the encoder. The total measuring range is calculated by multiplying the single turn resolution with the number of distinguishable revolutions.

Example: The total measuring range for a 25 bit multi turn encoder RXA 608 with a 13 bit single turn resolution and a 12 bit multi turn resolution, the permissible value range for the "Total measuring range" is between 2^0 and 2^{25} (33 554 432).

The total measuring range is calculated as below:

Measuring units per revolution x Total measuring range
= 8192 (2^{13}) x 4096 (2^{12})
= 33554432

If the total measuring range is higher than 31 bit, telegram 84 and acyclic encoder parameter 65002 and 65003 must be used. In this case the 64 bit values are used and the 32 bit values are set to zero (0) by the encoder.

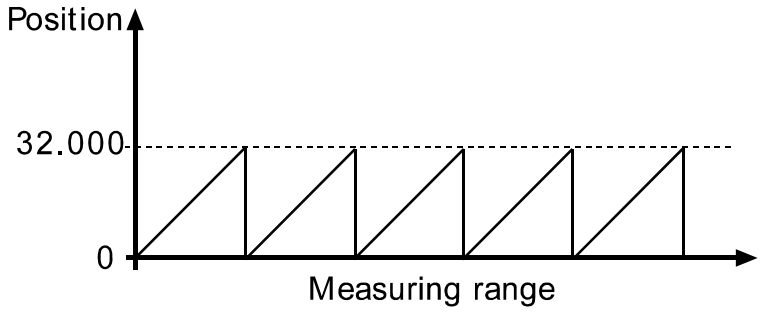
The device has two different operating modes, depending on the specified measuring range. When the device receives a parameter message, it checks the scaling parameters if a binary scaling can be used. If binary scaling can be used, the device selects operating mode A (see following explanation). If not, operating mode B is selected.

A. Cyclic operation (binary scaling)

Cyclic operation is used when operating with 2^X number of turns (2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048. 4096….. number of turns). If the desired total measuring range is equal to the specified single turn resolution * 2^X (where x<= 12) the encoder operates in endless cyclic operation (0 – max – 0 –max…). If the position value increases above the maximum value by rotating the encoder shaft, the encoder continues from 0.

Example of a cyclic scaling:

Measuring units per revolution	= 1000
Total measuring range	= 32 000 (2^5 = number of revolutions 32)



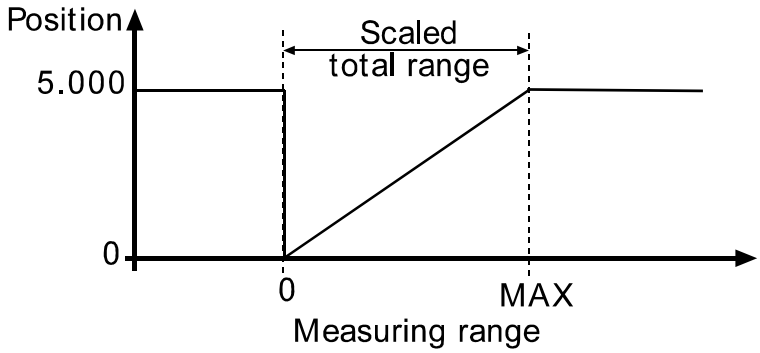
Cyclic Scaling

B. Non-cyclic operation

If the measuring range is used to limit the encoder value range to a value not equal to the specified single turn resolution *** 2^x**, the output position value is limited within the operating range. If the position value increases or decreases outside the measuring range by rotating the encoder shaft beyond the maximum value or below 0, the device outputs the total measuring range value.

Example of non-cyclic scaling:

Measuring units per revolution	= 100
Total measuring range	= 5000 (number of revolutions 50)



Non-cyclic scaling

Handling 64 bit data

Siemens hardware configuration tool does not support 64 bit data type, so when writing larger numbers than 32 bit into the configuration tool, this needs to be done according to below:

Example:
Total measuring range in measuring units = 2^{36}

$2^{36} = 68719476736_{10} = 0x\underbrace{00\ 00\ 00\ 10}_{\text{MSB: 4 byte = 32 bit}}\underbrace{00\ 00\ 00\ 00}_{\text{LSB: 4 byte = 32 bit}}$

Take the 4 least significant bytes above and convert to decimal:
→0x00 00 00 00 = **0** = Total measuring range LSB

Then take the 4 most significant bytes above and convert to decimal:
→0x00 00 00 10 = **16** = Total measuring range MSB

In the configuration software enter the decimal values:
Total measuring range LSB = **0**
Total measuring range MSB = **16**

9.9 Maximum Master Sign-Of-Life failures

With this parameter the number of allowed failures of the master´s sign of life is defined. The default value is one (1).

Parameter	Meaning	Value
Maximum Master Sign-Of-Life failures	The number of permissible failures of the master´s life sign.	1…255

Maximum Master Sign-Of-Life parameter

Note: This parameter is only supported in compatibility mode.

9.10 Velocity measuring units

This parameter defines the coding of the velocity measuring units used to configure the signals NIST_A and NIST_B. Standard telegram 81 has no velocity information included and the encoder does not use the velocity unit information in this case. Telegram 82, 83 and 84 includes velocity output and needs a declaration of the velocity measuring unit.

Parameter	Meaning	Value
Velocity measuring units	Definition of the units for the Encoder velocity output value.	See table below

Parameter Velocity measuring unit

Velocity measuring units	value
Steps/s	0
Steps/100 ms	1
Steps/10 ms	2
RPM	3

Coding of velocity measuring units

The velocity calculations are made with a maximum of 19 bits resolution. If the resolution is higher than 2^{19}, the value used for velocity calculations is automatically reduced to 2^{19}.

Example: For a 37 bit multi turn encoder with a 2^{25} single turn resolution and a 2^{12} multi turn resolution, the maximum single turn value for velocity calculations will be 2^{19}. For a single turn encoder the maximum resolution can be up to 31 bit, but the value used for velocity calculations will in this case also be 2^{19}.

Note: In case of the steps/s unit, an average is made over 200 ms, and the value is multiplied by 5.

Note: If scaling has been set on the device the velocity calculation is based on the scaled position value. Consequently the accuracy of the velocity value is dependent of the scaling set to the device.

9.11 Encoder profile version

The encoder Profile Version is the version of the encoder profile document implemented in the encoder. This parameter is not affected by the Compatibility mode settings.

Bits	Meaning
0…7	Profile Version, least significant number, (value range: 0-99), decimal coding
8…15	Profile Version, most significant number, (value range: 0-99), decimal coding
16…31	Reserved

Encoder profile version Parameter

9.12 Operating time

The operating time monitor stores the operating time for the device in operating hours. The operating time is saved every six minutes in the non-volatile memory in the device. This happens as long as the device is powered on.

If the operating time function is not used the operating time value is set to the maximum value (0xFFFF FFFF).

Parameter	Meaning	Data type
Operating time	The accumulated power on time	Unsigned 32

Operating time parameter

9.13 Offset value

The offset value is calculated in the preset function and shifts the position value with the calculated value. The offset value is stored in a non volatile memory and can be read from the encoder at any time. The data type for the offset value is a 32 bit or 64 bit binary value with sign, whereby the offset value range is equal to the measuring range of the device.

The preset function is used after the scaling function. This means that the offset value is indicated according to the scaled resolution of the device.

Parameter	Meaning	Data type
Offset value	The offset value for encoders with a measuring range of maximum 32 bits	Integer 32
Offset value 64 bit	The offset value for encoders with a measuring range exceeding 32 bits	Integer 64

Offset value parameter

Note: The offset value is read only and cannot be modified by a parameter write access.

9.14 Acyclic data

Leine & Linde's PROFINET encoders support the following acyclic data exchange functions.

9.14.1 PROFIdrive parameters

The encoder profile V4.1 (PNO no. 3.162) has adopted certain standard PROFIdrive parameter. The Leine & Linde encoders support the following PROFIdrive parameters:

PNU (Prm.no)	Significance	Data type	Read/Write
922	Telegram selection	Unsigned 16	R
925	Number of Controller Sign-Of-Life failures which may be tolerated	Unsigned 16	R/W
964	Device indentification	Array [n] Unsigned 16	R
965	Encoder Profile Number	Octet string 2	R
971	Transfer to non volatile memory	Unsigned 16	W
974	Base Mode Parameter Access service identification	Array [n] Unsigned 16	R
975	Encoder Object identification	Array [n] Unsigned 16	R
979	Sensor format	Array [n] Unsigned 32	R
980	List of supported parameters	Array [n] Unsigned 16	R

PROFIdrive parameters supported

9.14.2 Encoder parameter numbers

The table below specifies the encoder specific parameter that is supported by Leine & Linde PROFINET encoders.

PNU Prm. No	Significance	Data type	Read/Write
61000	Name of station	Octet String [240]	R
61001	IP of station	Unsigned32	R
61002	MAC of station	Octet String[6]	R
61003	Default gateway of station	Unsigned 32	R
61004	Subnet Mask Of Station	Unsigned 32	R
65000	Preset value	Integer 32	R/W
65001	Operating status	Array [n] Integer 32	R
65002	Preset value 64 bit	Integer 64	R/W
65003	Operating status 64 bit	Array [n] Integer 64	R

Encoder specific parameter

9.14.3 Parameter 65000 and 65002 – Preset value

The parameter 65000 and 65002 sets the value for the preset function. The parameter 65002 should be used if the preset value exceeds 32 bits. For more information regarding the Preset function control, see chapter 9.7.

PNU	65000
Significance	Preset value
Data type	Integer 32
Access	Read and write
Validity range	Profile specific
Explanation	The preset value sets the value for the preset function. The preset value can be stored in the non volatile memory by PROFIdrive parameter 971 and will be reloaded at each start up if stored.

Structure of parameter 65000 "Preset value"

PNU	65002
Significance	Preset value 64 bit
Data type	Integer 64
Access	Read and write
Validity range	Profile specific
Explanation	The preset value sets the value for the preset function. The preset value can be stored in the non volatile memory by PROFIdrive parameter 971 and will be reloaded at each start up if stored.

Structure of parameter 65002 "Preset value 64 bit"

9.14.4 Parameter 65001 –Operating status parameter structure

This parameter structure is a read only structure where information on the Encoder operating status can be found. It is a complement to the PROFIdrive parameter 979 described in the Profile for Drive Technology, PROFIdrive V4.1, Order nr 3.172 available from PROFIBUS and PROFINET International.

PNU	65001
Significance	Encoder Operating Status
Data type	Array[n] Integer 32
Access	Read
Validity range	Profile specific
Explanation	The operating status displays the status of the encoder.

Sub index	Meaning
0	Header
1	Operating status
2	Faults
3	Supported Faults
4	Warnings
5	Supported warnings
6	Encoder Profile version
7	Operating time
8	Offset value
9	Measuring units per revolution
10	Total measuring range in measuring units
11	Velocity measuring unit

Structure of parameter 65001 "Operating status"

Sub index 1: Operating status

In sub index 1 the status of different encoder functions can be read out. The mapping of the respective functions is according to the table below.

Bits	Definition
0	Code sequence
1	Class 4 functionality
2	G1_XIST1 Preset control
3	Scaling function control
4	Alarm channel control
5	Compatibility mode
6...7	Reserved for the Encoder manufacturer
8…31	Reserved for future use

Parameter 65001 Sub index 1: Operating status

9.14.5 Encoder specific parameter 65003 – Operating status 64 bit structure

The parameter structure 65003 is a read only structure where information on the 64 bit parameter values can be found.

PNU	65003
Significance	Encoder Operating Status 64 bit
Data type	Array[n] Integer 64
Access	Read
Validity range	Profile specific
Explanation	The status of encoder operating parameters with 64 bit length.

Sub index	Meaning
0	Header
1	Offset value 64 bit
2	Measuring units per revolution 64 bit
3	Total measuring range in measuring units 64 bit

Structure of parameter 65003 "Operating status 64 bit"

9.14.6 I&M functions

In addition to the PROFIdrive parameter 964, Device Identification, I&M functions are supported by the encoder. The I&M functions can be accessed with record index 0xAFF0-0xAFF4. The Leine & Linde encoder supports the following I&M functions.

I&M Parameter	Octets	Comment
Header		
Manufacturer specific	10	Not used
I&M Block		
MANUFACTURER_ID	2	Manufacturer Id, (Leine & Linde = 394)
ORDER_ID	20	Encoder part number
SERIAL_NUMBER	16	Encoder serial number
HARDWARE_REVISION	2	Not used
SOFTWARE_REVISION	4	Software revision
REVISION_COUNTER	2	Not used
PROFILE_ID	2	Encoder Profile number
PROFILE_SPECIFIC_TYPE	2	Type of encoder,
IM_VERSION	2	Version of the I&M profile
IM_SUPPORTED	2	Value = 0 means support of I&M

Supported I&M functions

10. Firmware upgrade

The Leine & Linde encoder supports a firmware upgrade function. The firmware upgrade function is developed to offer the possibility to upgrade the encoders in the future.

Before the upgrade of the encoder can start, the following tools are needed:

- A running TFTP server
- A WEB browser (Internet Explorer, Firefox, Safari, Opera etc.)
- DHCP server
  (This is only needed if performing an upgrade outside a PROFINET network)

The encoder itself puts no restrictions on what TFTP/DHCP server to use. The customer can choose to use any TFTP/DHCP servers.

There are two different scenarios for software upgrade:

- Firmware upgrade in a PROFINET network.
  This is when the encoder is connected to a PROFINET network. The encoder will be provided with an IP address from the PROFINET IO controller (with DCP).

- Stand alone upgrade.
  This is when the encoder is outside a PROFINET network. A DHCP server is required in order to provide the encoder with a valid IP address. This scenario might be valid if the encoder is a spare part or an encoder is picked out of a system for maintenance. There is currently not support for “bulk upgrade”. I.e. each encoder must be accessed and upgraded in turn.

10.1 Firmware upgrade in a PROFINET network

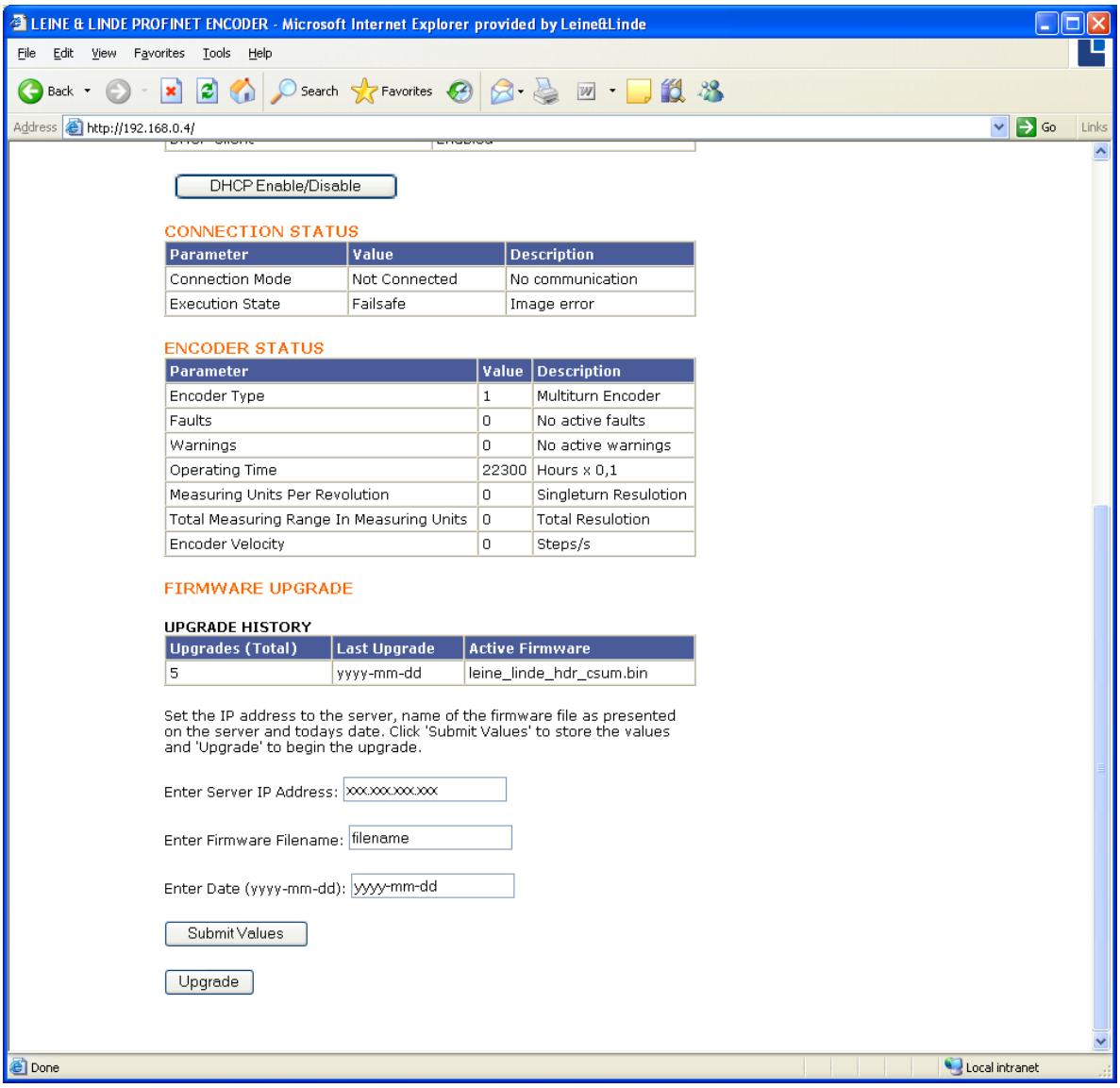
The following prerequisites have to be fulfilled in order to upgrade the encoder in a PROFINET network:

- The encoder should be attached to the network.
- The encoder must have a valid Device name and a valid IP address (assigned with DCP).
- A TFTP server should be enabled on the LAN where the encoder is attached. See chapter 10.4 for an example how to set up a TFTP server.

Once the encoder has been assign a valid IP address it should be accessible on the network. Enter the encoders IP address in the WEB browser.

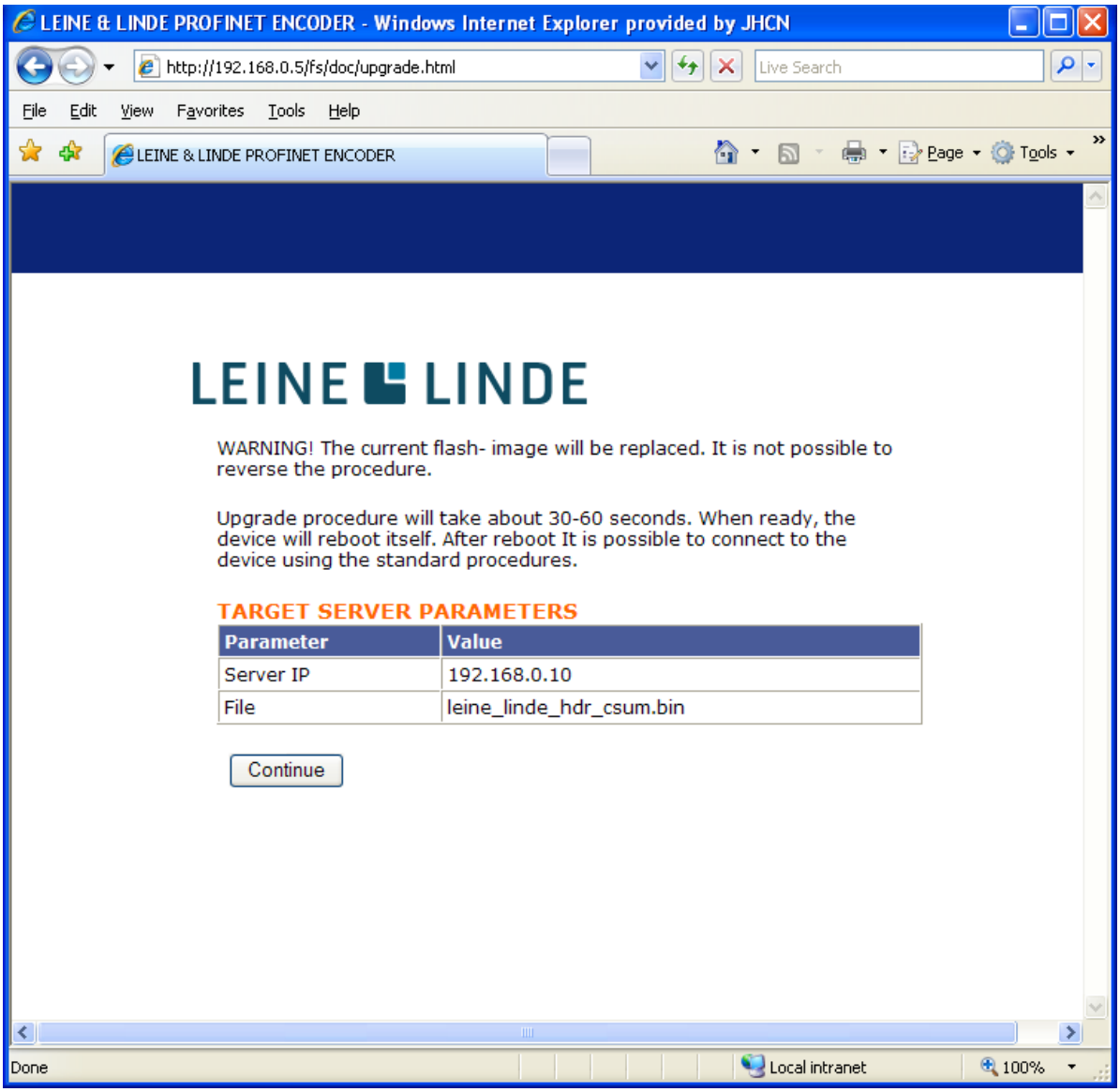
When accessing the encoder with the web browser it will display a number of parameters. In the firmware upgrade section of the page, enter the following information:

- Server IP address – Enter the IP address to the TFTP server on the LAN
- Firmware filename – Enter the full file name of the new firmware file supplied by the TFTP server
- Date – Enter the current date for the upgrade. This is stored as part of the “Upgrade History“. The format is yyyy-mm-dd. E.g. 2010-05-15.

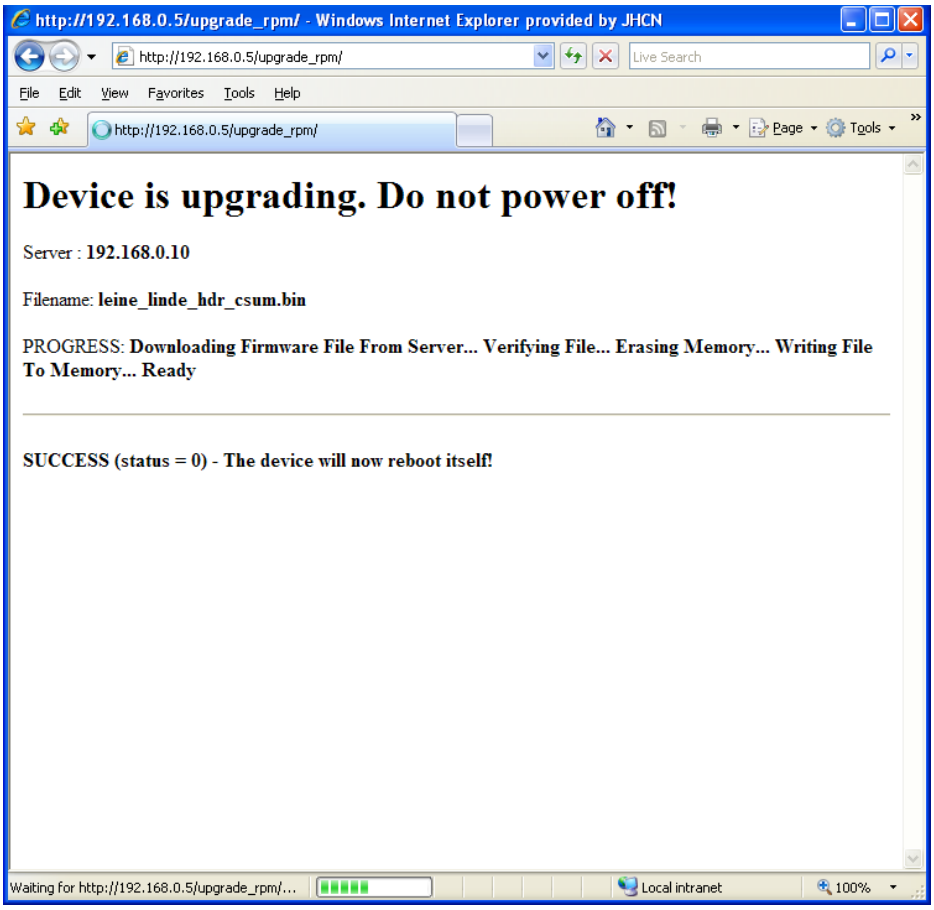


The parameters are set by clicking the “Submit Values” button. After clicking the “Submit Values” button, update the page in the web browser.
To start the upgrade, click on the “Upgrade” button.

A confirmation page is displayed where the upgrade has to be confirmed before the device starts the actual firmware upgrade process. The Continue button needs to be clicked in order to start the upgrade sequence.



During upgrade a “progress page“ is displayed. Depending upon the choice of web browser, the auto generated progress page will take some time to be displayed. However, the progress web page should always be displayed when the upgrade is finished. If no errors occur during upgrade the encoder will automatically reboot itself and connect to the PROFINET IO-controller with the new firmware.



During the upgrade, both the bus status LED and the device status LED will be flashing green. If an error occurs both LEDS will be flashing red.

If the upgrade fails check the error code displayed on the progress page. The error codes are described in chapter 10.3.

10.2 Stand alone upgrade

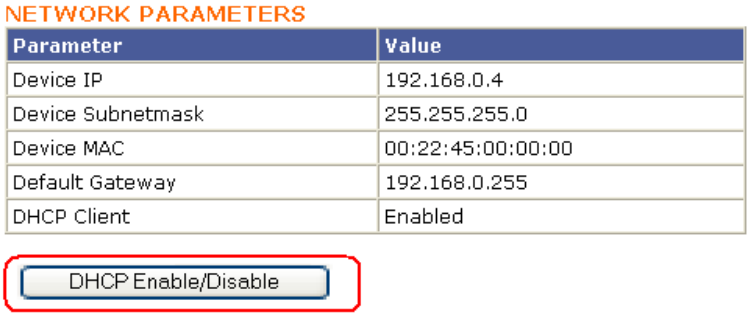
In order to start the stand alone upgrade the following prerequisites has to be fulfilled:

- The encoder should be attached to a LAN network
  (See chapter 10.6 LAN configuration).
- There should be a DHCP enabled server on the LAN where the encoder is attached. (See chapter 10.5 DCHP server installation)
- A TFTP server should be enabled on the LAN where the encoder is attached.
  (See chapter 10.4 TFTP server installation)

The encoder firmware contains a DHCP client for IP assignment outside a PROFINET network. If no IP address is assigned by a DCP/PROFINET IO controller, the encoder will try to retrieve an IP address with DHCP.

First start the DHCP and TFTP servers and then power up the encoder. After approximately 20-30 seconds the encoder should have received a valid IP address. When the encoder has received a valid IP address, continue with the same upgrade procedure as described in chapter 10.1, “Firmware upgrade in a PROFINET network”.

It is possible to disable/enable the DHCP client in the encoder. Use the “DHCP Enable/Disable” button on the startup web- page in order to toggle between the two modes. The encoder will keep this state until the user manually switches state again.


NETWORK PARAMETERS

Parameter	Value
Device IP	192.168.0.4
Device Subnetmask	255.255.255.0
Device MAC	00:22:45:00:00:00
Default Gateway	192.168.0.255
DHCP Client	Enabled

DHCP Enable/Disable

Any TFTP server can be used to retrieve file image and any DHCP server can be used to assign IP addresses. Supplied in this manual is a description on how to install SolarWinds TFTP server (chapter 10.4) and Tiny DHCP (chapter 10.5) from SoftCab on a desktop PC.

10.3 Error Handling

This chapter will list all the possible error codes that can occur during an upgrade error. The error code will be visible on the “feedback webpage”. If an error occurs the device will **not reboot** itself automatically. Instead it will wait upon user action. This is to allow the user to take the next step. E.g. the user might want to check some parameters before rebooting or try to run the upgrade procedure again.

Failed to download firmware file from server
Error code: -2

The user should verify the IP address and the image filename. If any of them is incorrect the user should go back and submit the correct parameters at the main html page (index.html). If the parameters are correct the user should verify that the TFTP server is running on the host computer and that the TFTP server settings are correct.

Host not responding/No contact with host computer
Error code: -3

The user should verify that the host computer is connected to the encoder. The ping command can be used for this purpose. If connected, go back to upgrade.html and click “Confirm” to try and upgrade again.

Checksum Error/File image error
Error code: -4

Calculated checksum doesn’t match the one supplied by the image file. The most likely cause for this problem is that there was an error when downloading the file to the encoder. Go back to upgrade.html and press “Confirm” and try again.

Flash Erase/Write Error
Error code: -5

The image might be corrupt. Flash Erase or Write failed. If this error occurs the device can still start with its failsafe image. It will be displayed by the “Execution State” parameter on the web Page.

File Size Error
Error Code: -6

The firmware file is too big to be written to flash.

Insufficient Memory
Error Code: -7

There is not enough memory available to store the firmware file image.

Invalid Firmware File
Error Code: -8

Firmware file is not supported for this hardware.

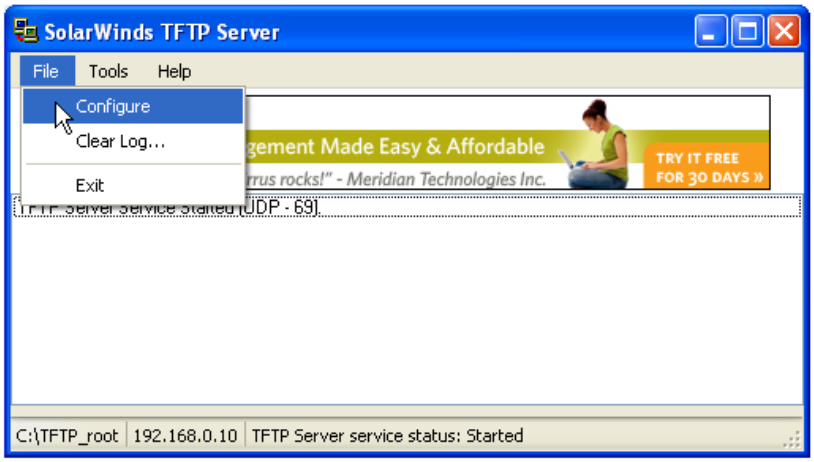
10.4 TFTP server installation

The TFTP server used in this example is a freeware TFTP server for Windows NT/XP/Vista platforms and it can be downloaded from www.solarwinds.com.

Unzip the installation file and double click on the SolarWinds-TFTP-Server.exe file to start the installation. Follow the instructions on the screen to complete the installation.

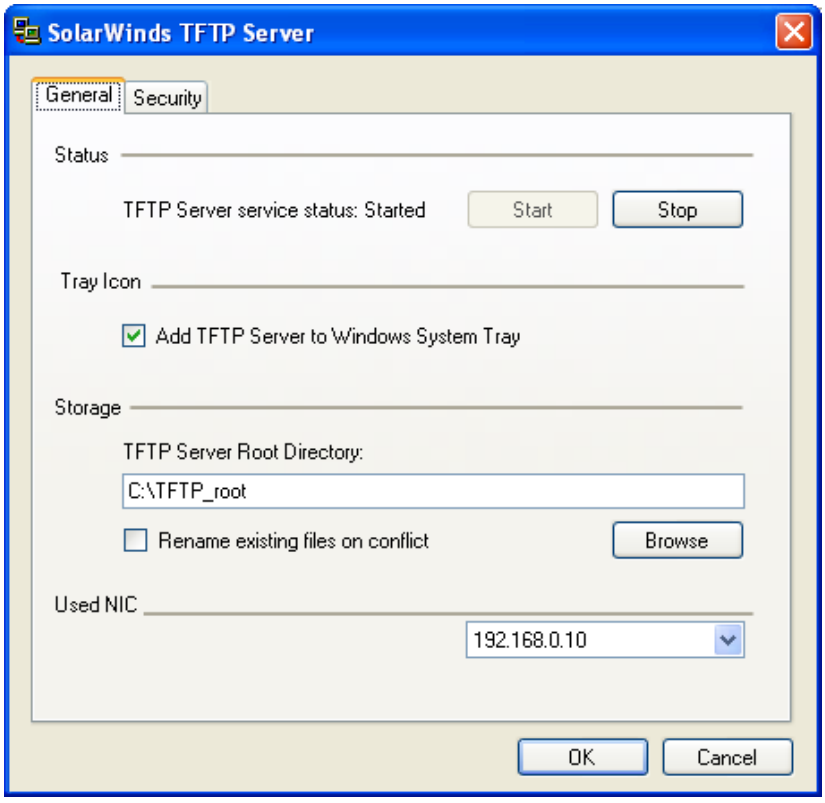
Create a folder on C:\ named TFTP_Root (if it not already exists). Copy or Move the new firmware file used to the C:\TFTP_Root directory.

Start the SolarWinds TFTP server and click on the File->Configure tab to open up the Configure window.



In the Configure window:

- Make sure that the correct network interface is selected in the “Used NIC” selection menu. I.e. it is the network interface which is connected to the encoder network.
- Set up the path to the TFTP root directory. I.e. the TFTP-Root directory created under C:\.
- Leave the other parameters with their default values.
- Click Start to start the TFTP server service in Windows.



Note: The server will listen to port 69. Verify that there is no firewall blocking the port for incoming/outgoing requests. Disable any firewall, temporarily, if experience communication problems.

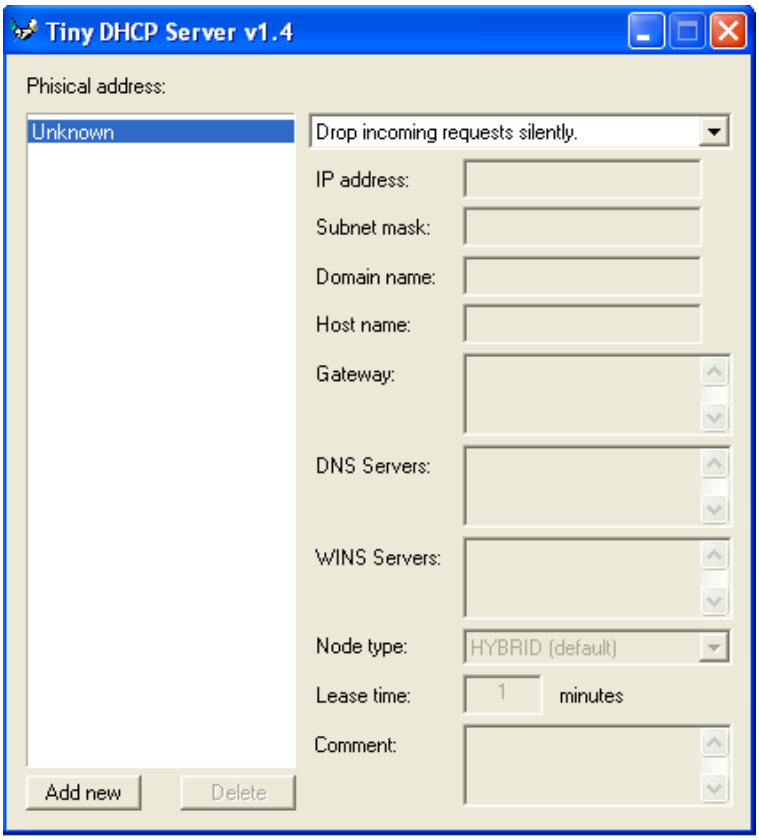
10.5 DHCP server installation

The DHCP server used in this example is a freeware DHCP server for Windows NT/XP/Vista platforms and can be downloaded from www.softcab.com.

Note: Before starting the installation, disconnect the PC (where the DHCP server is to be installed) from the office network. It can be connected to the network again when the server is configured.

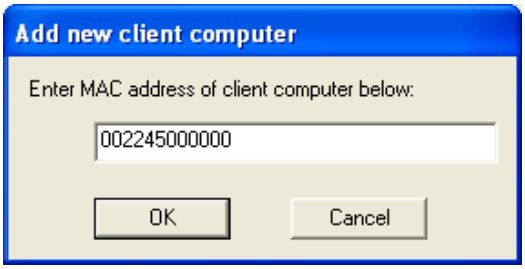
Once the DHCP server has been downloaded, double click on the dhcp.exe file to start the installation and follow the instructions on the screen.

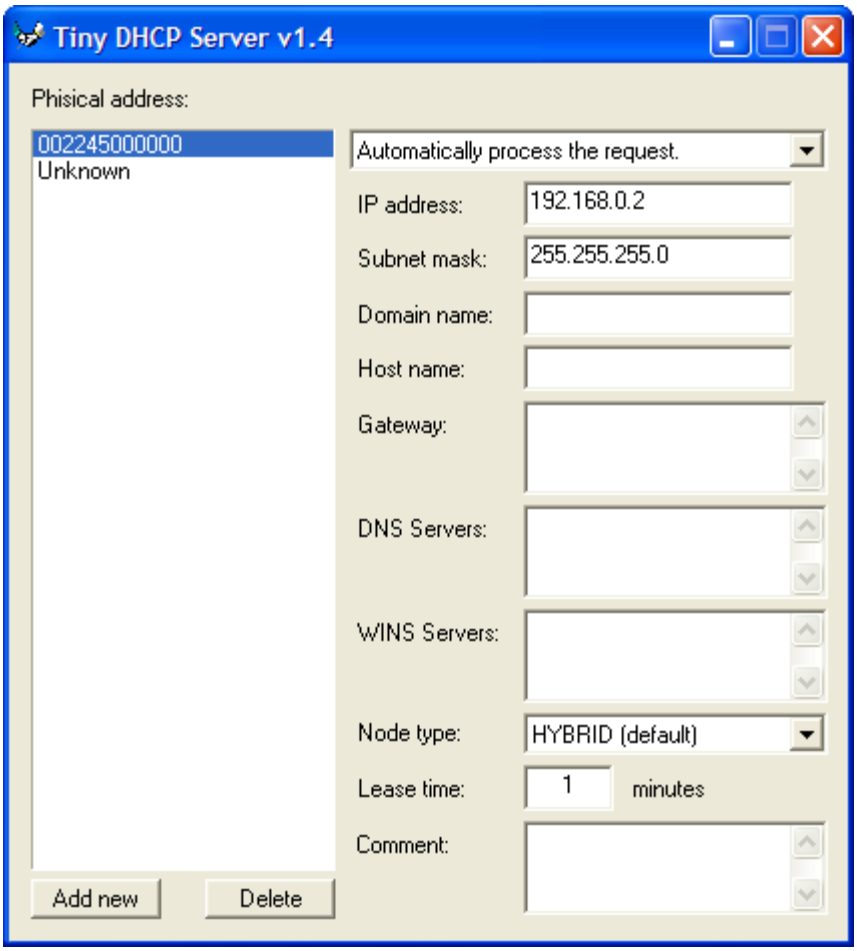
After installation, start the Tiny DHCP server program.



The “Unknown” physical address is predefined. Select “Drop incoming requests silently” for unknown interfaces.

Select “Add new” and enter the MAC address of the device you attend to supply with an IP address. The MAC address for the encoder is written on the encoder label.



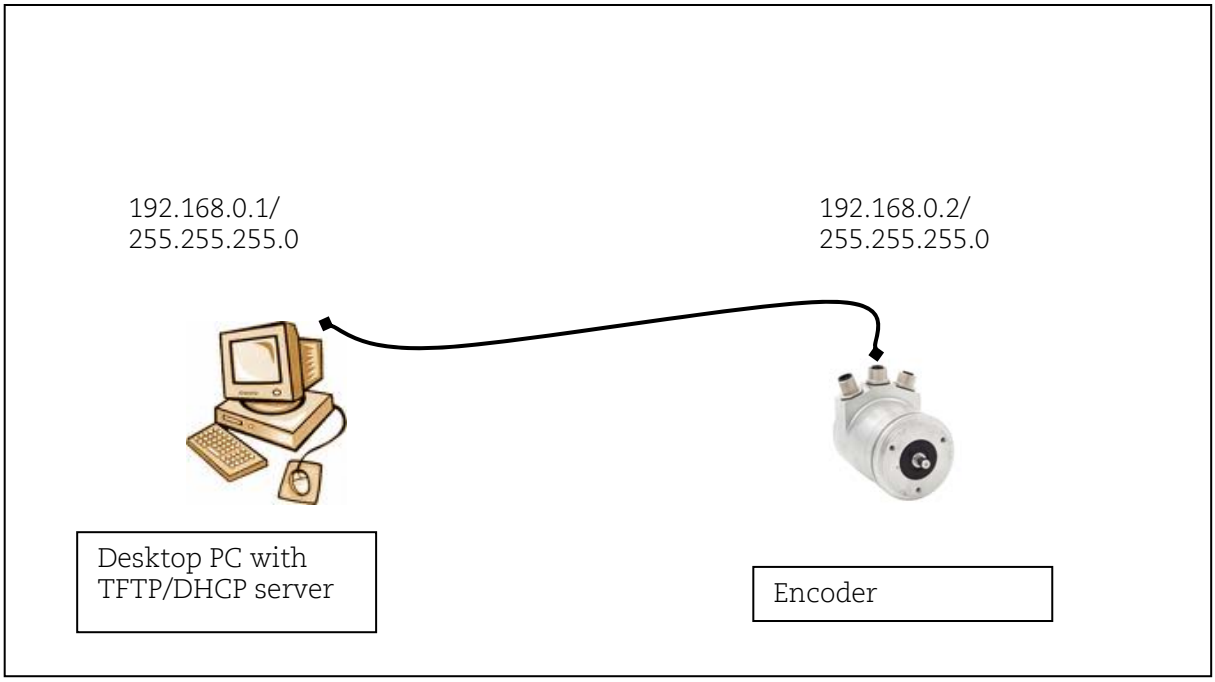


Provide the appropriate settings for the target device. It is important to make sure that the IP address of the encoder is on the same network as the desktop PC. The first three bytes of the IP address needs to be the same on the PC and the encoder.
If for example the PC have an IP address of 192.168.0.1 and subnet mask 255.255.255.0 the IP address of the encoder can be set to 192.168.0.2 and subnet 255.255.255.0.

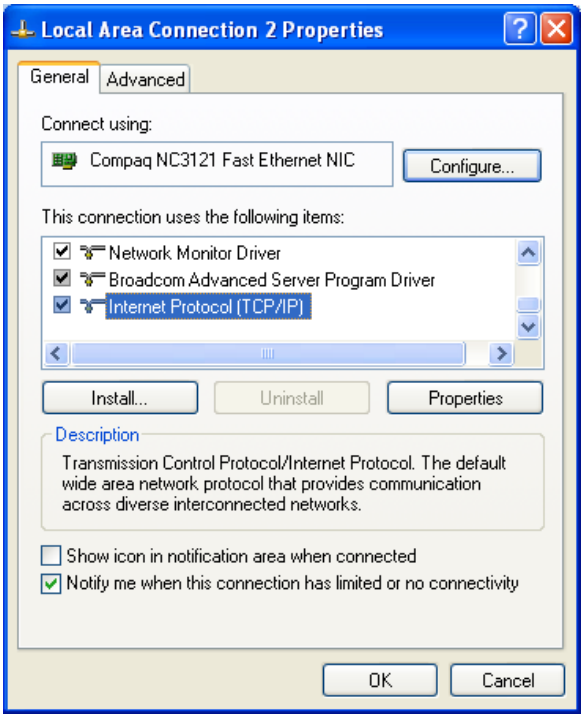
Once the above configuration is made the PC can be connected to the office network again if necessary.

10.6 LAN Configuration

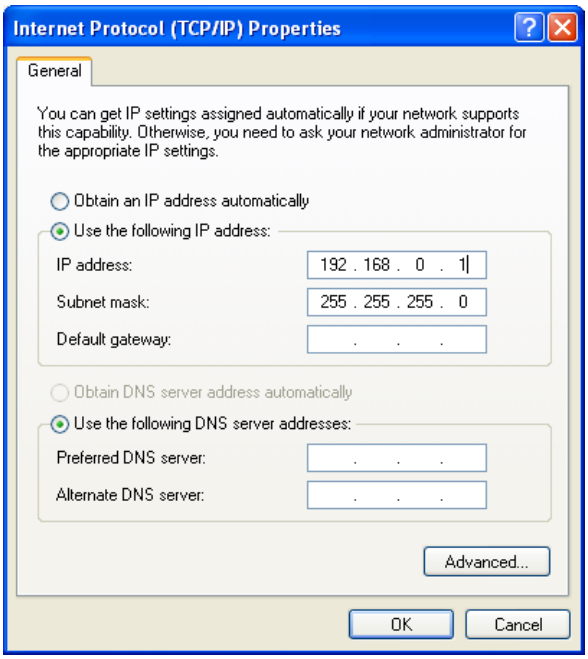
The picture shows a typical setup in order to upgrade the encoder.



Consider the connection between the desktop PC and the encoder. The encoder and the desktop PC both have to be on the same logical LAN. In order to set the IP address of the desktop PC (windows). Go to the “Control Panel” and select “Network Connection”. Right click on the network interface connected to the local LAN. Then open the properties for the Internet Protocol (TCP/IP).



Set the appropriate IP address and Subnet mask for the interface according to the example below.



Use Tiny DHCP server to provide the encoder with a valid IP address (See chapter 10.5).

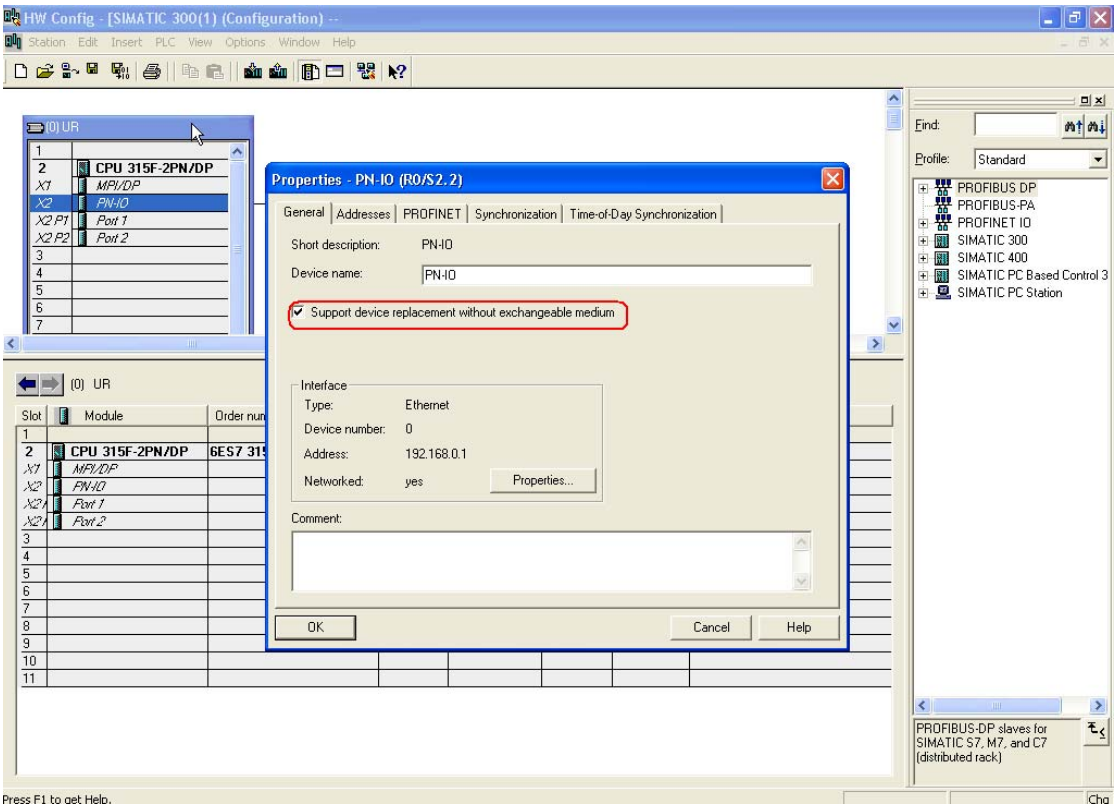
Note: It is recommended to keep the desktop PC disconnected from the office network to avoid issues with the office network.

11. Encoder replacement using Link Layer Discovery Protocol (LLDP)

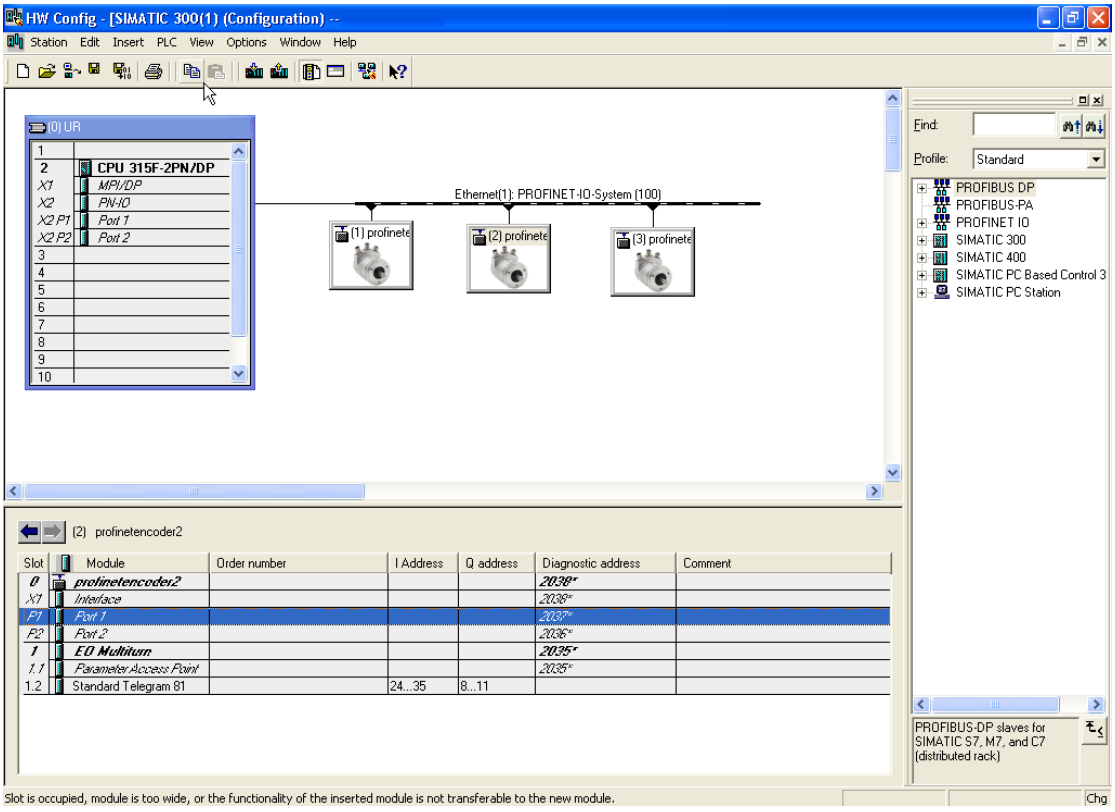
The encoder supports Link Layer Discovery Protocol (LLDP). LLDP is essentially a neighbor discovery protocol used by network devices for advertising of their identity, capabilities and interconnections.

In a PROFINET network all IO devices are recognized by their device name. Sometimes an IO device needs to be replaced in an automation system, and this is when LLDP is useful. Using LLDP, the neighbor relations between the individual IO device and the IO controller are analyzed and stored on the IO controller. If an IO device has been replaced, the IO controller will recognize this and will redefine the device name.

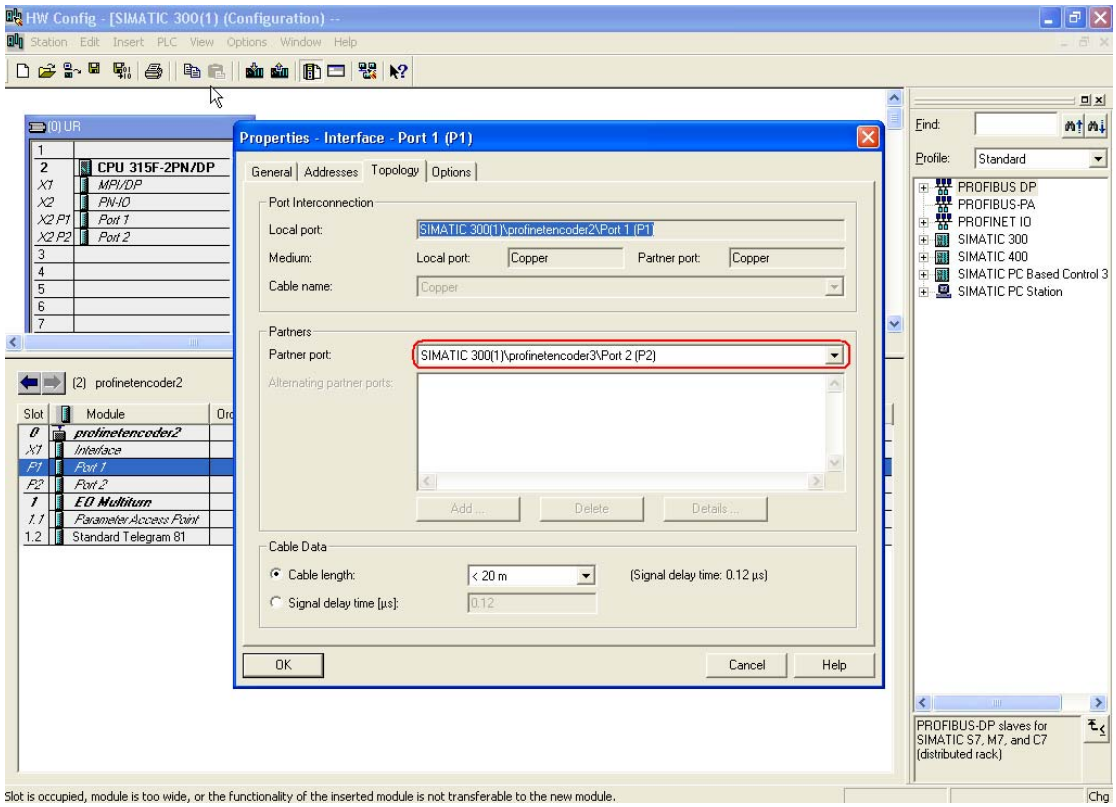
Follow the instruction below to exchange an IO device using LLDP:
Select properties of the PN-IO controllers interface module and enable Support device replacement without exchangeable medium.



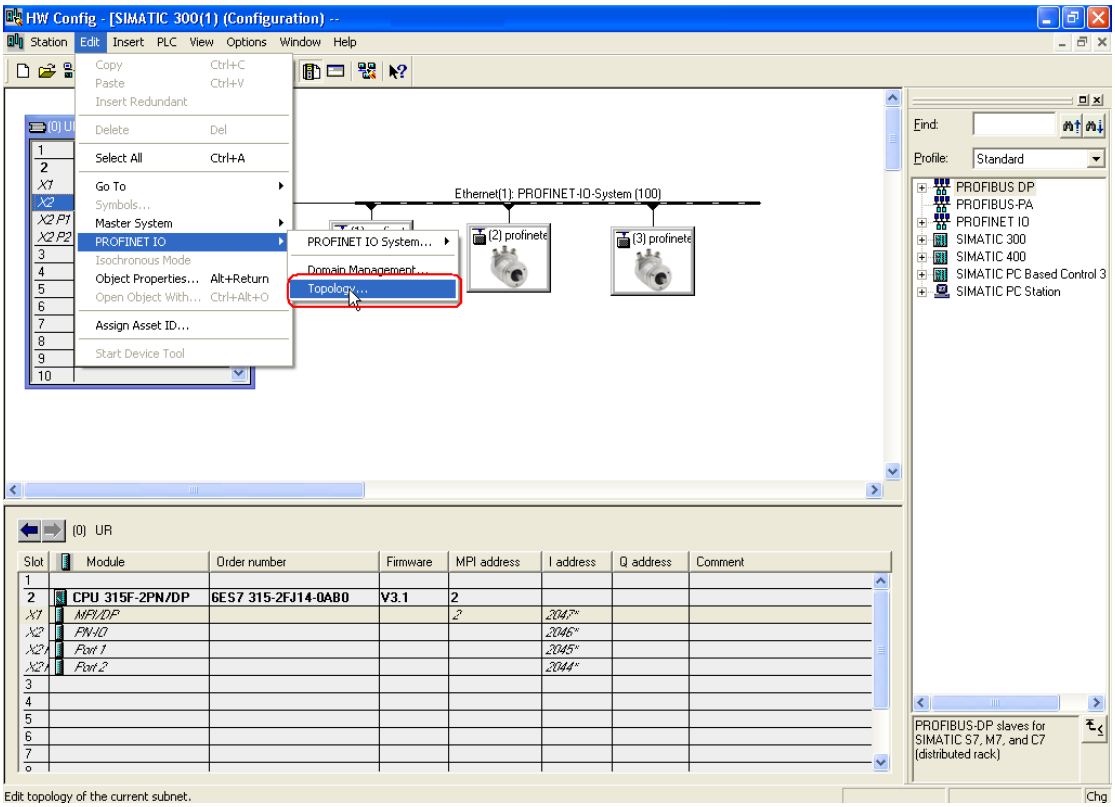
Configure the topology of the system for all connected ports.

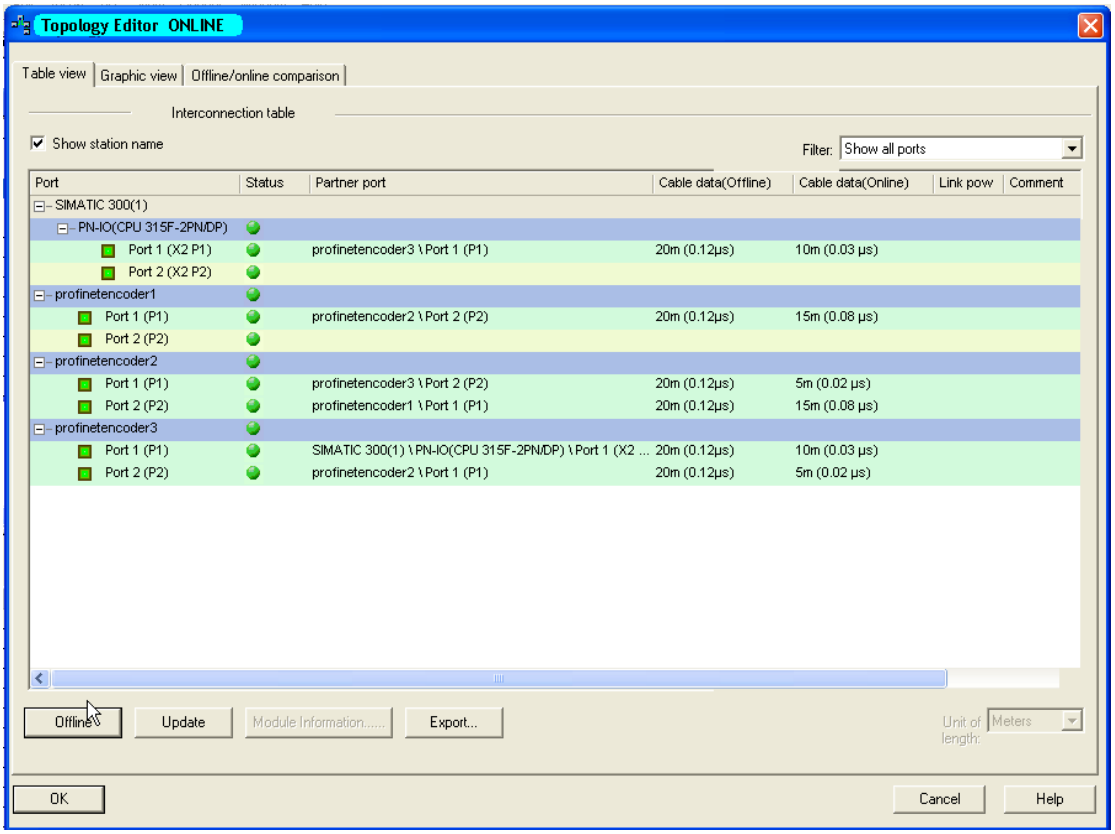


In the properties window, select the corresponding partner port.



Then select Edit-> PROFINET IO->Topology to open the “topology editor.



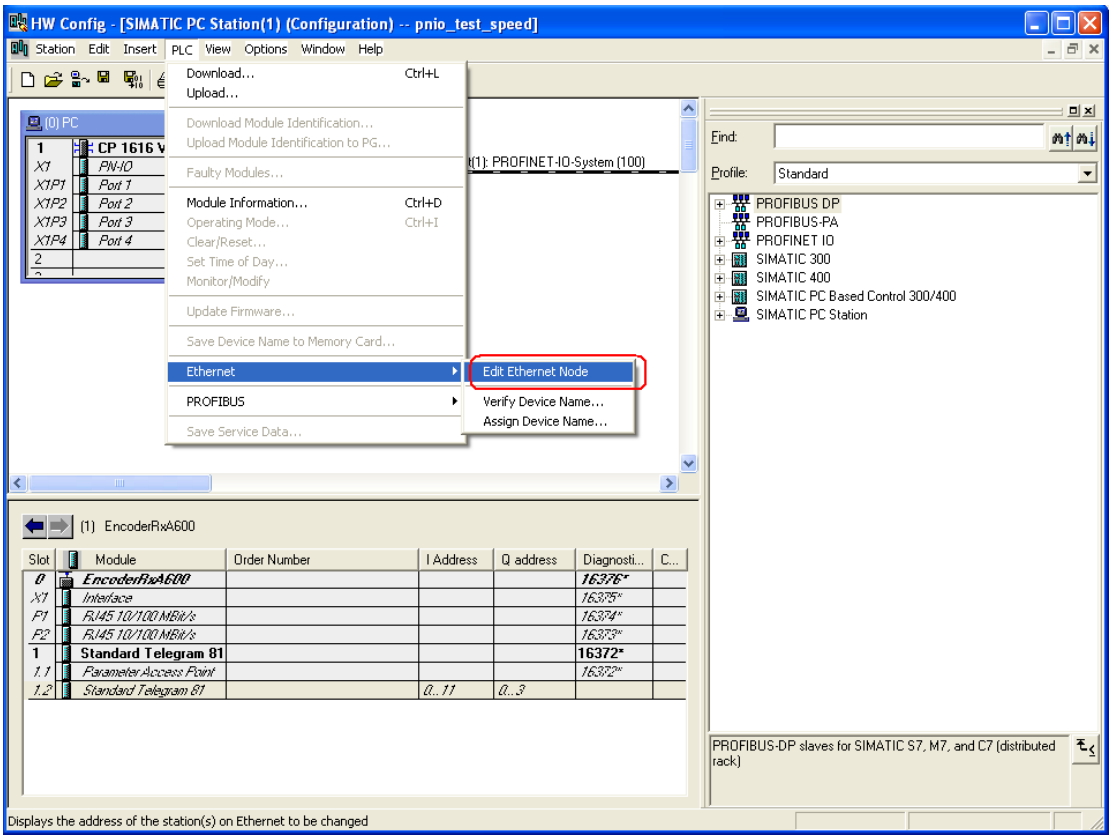


Verify that the offline topology matches the online topology.

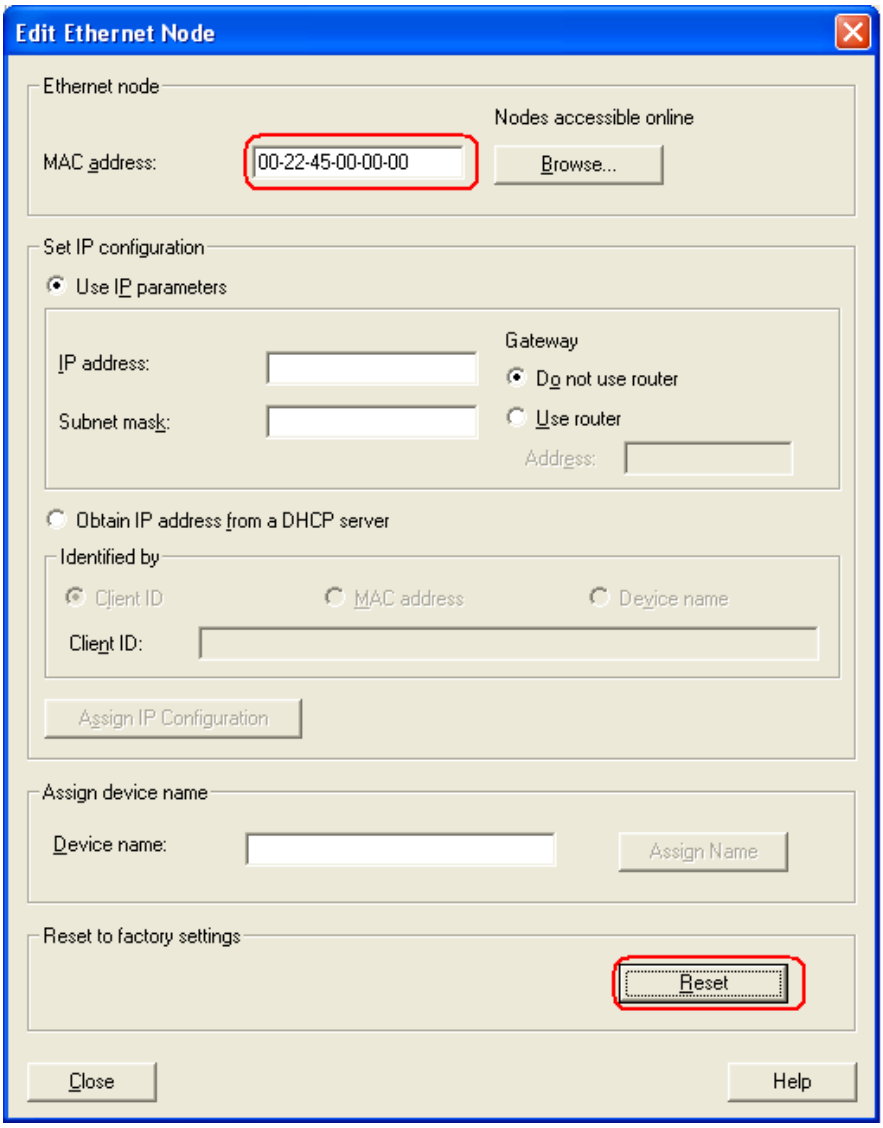
After the above has been verified it is possible to replace any IO device if the ports are reconnected in the same way and the new device is set to factory reset.

To manually do a factory set of the encoder, follow the steps below:

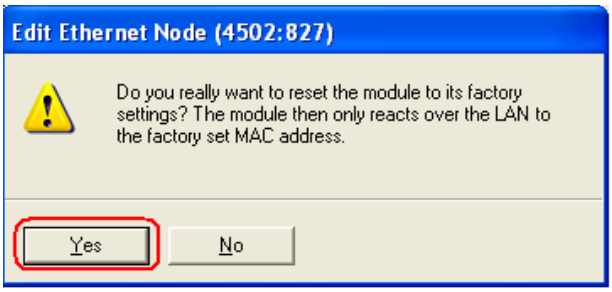
Select PLC-> Ethernet-> Edit Ethernet Node.



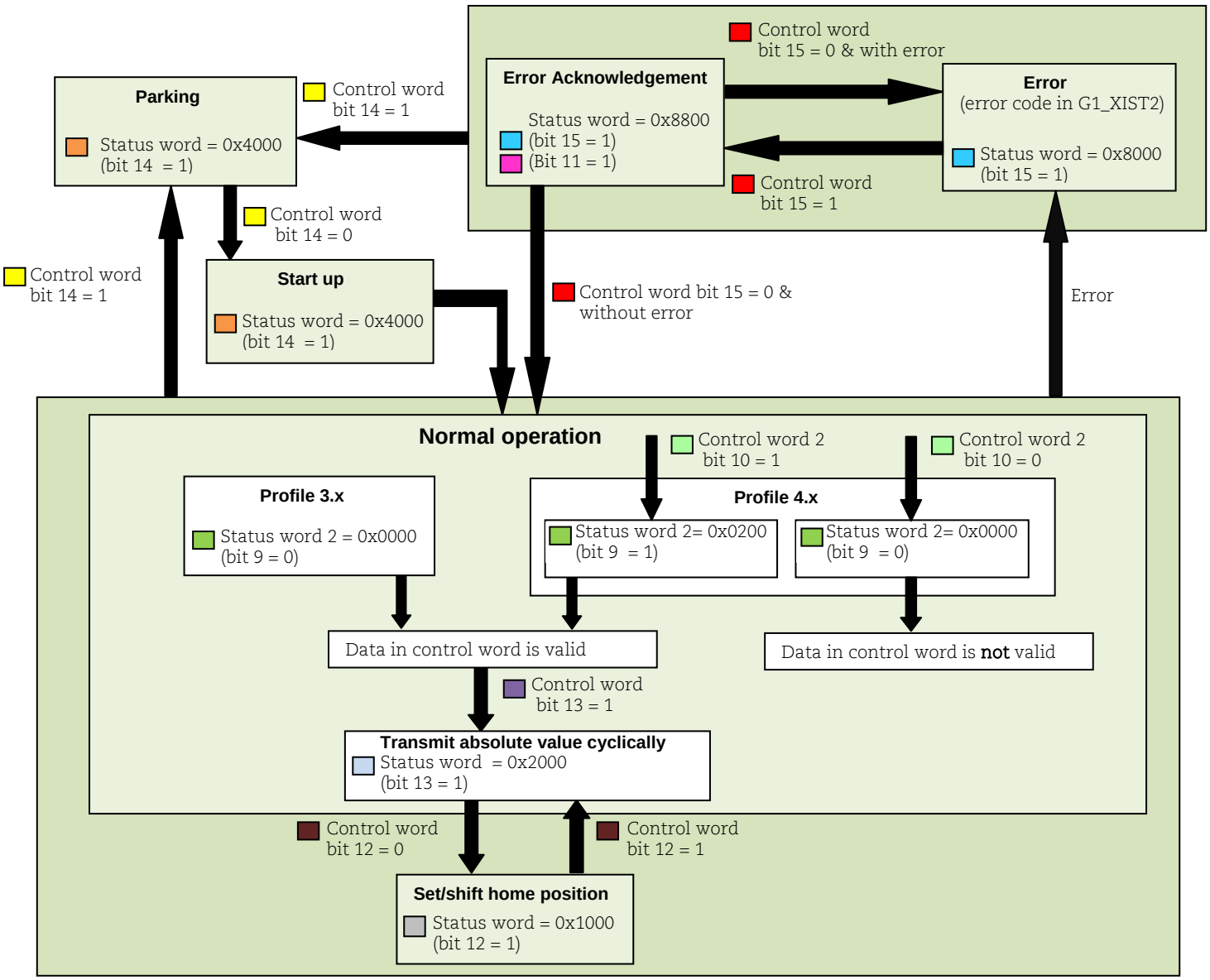
Enter the encoder´s MAC-adress and then click on the Reset button. The MAC-adress of the encoder is written on the encoder label.



Click yes in the confirmation window to reset the encoder to its factory settings.



12. Encoder state Machine



Control word (G1_STW)	
Bit	Function
12	Request set/shift of home position (Preset)
13	Request absolute value cyclically
14	Activate parking sensor
15	Acknowledging a sensor error

Status word (G1_SZW)	
Bit	Function
11	Requirement of error acknowledgement detected
12	Set/shift of home position executed
13	Transmit absolute value cyclically
14	Parking sensor active
15	Sensor error

Control word 2 (STW2_ENC)	
Bit	Function
10	Control by PLC

Status word 2 (ZSW2_ENC)	
Bit	Function
9	Control requested

12.1 Normal Operation state

12.1.1 Profile Version 4.x

If using encoder complying with encoder profile v4.1, then bit 10 “Control by PLC” in Control word 2 needs to be set before the data in Control word is valid. If not set, Control word is not used by the encoder firmware.

12.1.2 Profile Version 3.x

If using encoders complying with encoder profile 3.x, the data in Control word is always valid and bit 9 “Control requested” in Status word 2 is always cleared.

12.1.3 Profile Version 3.x and 4.x

When using telegram 81-83 and Control word bit 13 ”Request absolute value cyclically” is set, then Status word bit 13 ”Transmit absolute value cyclically” is set. Status word bit 13 is cleared (bit 13=0) when Control word bit 13 is cleared. Status word bit 13 is always cleared, when using telegram 84 due to the fact that no absolute value is sent in G1_XIST2.

12.2 Parking state

This state can be reached from any other state. The position value in G1_XIST1, G1_XIST2 and G1_XIST3 are set to zero. Errors are cleared and alarms are disabled in parking mode.

12.3 Set/shift home position (Preset)

The Set/shift home position is initiated when Control word bit 12 ”Request set/shift of home position ” is set. In this case the Status word bit 12 ”Set/shift of home position executed” is set to 1. In order to initiate a set/shift home position, Class 4 functionality must be enabled (see chapter 9.2), otherwise there will be an error in G1_XIST2.

12.3.1 Preset depending on different telegrams

When using standard telegram 81-83, the acyclic encoder parameter 65000 “Preset value 32” bit shall be used to set a preset value (<=32 bit) for the encoder. If the acyclic encoder parameter 65002 “Preset value 64 bit” is used in this case, an error message will be returned. With telegram 81-83, the operating status must be read by encoder parameter 65001 ”Operating status 32 bit”.

With telegram 84, the acyclic encoder parameter 65002 “Preset value 64 bit” shall be used to set a preset value (<=64 bit) for the encoder. If the acyclic encoder parameter 65000 ”Preset value 32 bit” is used in this case, an error message will be returned. With telegram 84, the operating status must be read by encoder parameter 65003 “Operating status 64 bit”.

12.3.2 Absolute preset with negative value

Preset data sent with acyclic encoder parameter 65000 or 65002 are signed values. The relative preset mode uses signed preset values, but with the absolute preset mode no preset will be made if a negative preset value (set with encoder parameter 65000 or 65002) is used while trying to initiate an absolute preset.

12.4 Error state

This state is reached when an error has occurred. The encoder can enter this state from both the normal operation state and the set/shift home position state. If an error occurs, the Status word bit 15 “Sensor error” is set, and the error code is displayed in G1_XIST2 instead of the position value.

12.5 Error acknowledgement

This state is reached when an error has occurred, and Control word bit 15 “Acknowledging a sensor error” has been set. The Status word bit 11 “Requirement of error acknowledgment detected” and Status word bit 15 “Sensor error” are set to 1.

12.6 Start Up

This state is only reached when Control word bit 14 “Activate parking sensor” are cleared (=0). Once the Control word bit 14 are cleared, it takes about 500ms before the Status word bit 14 “Parking sensor active” are set to zero (=0).
The reason for the delay is that before the encoder goes to normal operation mode, an initializing of the encoder is made.

13 Frequently asked questions FAQ

1. Problem: Preset, parking mode and error reset is not possible.
   Solution The Control By PLC bit in Control Word 2 has to be set to 1 (Profile V4.1).

2. Problem: The preset value is lost if the power supply is switched off.
   Solution: Parameter 971 has to be set to 1 in order to save the preset value into non volatile memory.

14 Revision history

Revision	Date	Changes
Rev. 1.0	2010-05-20	First release